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Rio Blanco Oil Shale Project

PROGRESS REPORT 9 - SUMMARY

SEPTEMBER · OCTOBER · NOVEMBER 1976

Gulf Oil Corporation
and
Standard Oil Company (Indiana)
9725 East Hampden Avenue, Denver, Colorado 80231

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TN
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.C64
R565
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Summ.
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PROGRESS REPORT 9 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

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to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

15 February 1977

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana), hereafter referred to in this report as RBOSP, is presenting its ninth summary progress report for Tract C-a to the USGS Area Oil Shale Supervisor (AOSS). This report is a summary of work accomplished during the period 1 September 1976 through 31 November 1976. The baseline data gathered for the project are on file in the Area Oil Shale Supervisor's Office in Grand Junction Colorado. These data and its interpretive text comprise Progress Report 9. This summary report presents an overview and highlights of these data and has been correlated to and organized consistent with Progress Report 9; that is, the numbering system and topic headings for the Summary Report are the same as that used in the Progress Report. For more detailed information, the reader should refer to the Progress Report.

This ninth summary report represents the last summary report to the AOSS. Most of the environmental baseline programs have been completed and reported in this and previous Progress Reports and Summaries. The completion of the remaining programs will be reported to the AOSS in subsequent Progress Reports accompanied by the appropriate data. In addition, all remaining data taken previously but not yet available will also be included in subsequent Progress Reports. Analyses and interpretation of all data in the environmental baseline program is presently underway and will be presented as part of the final report to be submitted to the AOSS in mid-1977.

As has been done for Progress Reports 2 through 8, the numbering system for this report is consistent with those of the previous report. Therefore, a reader desiring information on the same subject in the previous reports (both Summary and Progress Reports) will find it under the same title heading and number. For this Progress Report, only those tasks are included for which activity was reported for the quarter. The Table of Contents for the Geotechnical Data Gathering Project lists only those programs that are still being worked; all other programs are complete. An index of all the tasks reported in previous progress reports is included in this section. The Table of Contents for the Environmental Baseline Data Gathering Project lists all the programs under investigation. Where programs indicate "no data collected", the numbers are left out of the text portion.

Additional information for the subjects covered in this progress report can be found in the following:

- Tract C-a Detailed Development Plan - March 1976
- Progress Reports 1 through 8 on file with the AOSS
- Annual Report - Tract C-a - Terrestrial Ecology Baseline Studies - March 1976

- Annual Report - Tract C-a - Aquatic Ecology Baseline Studies - March 1976

For general informational purposes in this report, two figures are shown. Figure 1 is a location map of Tract C-a showing major drainages, roads, towns and counties in the vicinity of the tract. Figure 2 shows Tract C-a in greater detail and generally locates the drill holes, stream gaging stations, air quality towers and roads.

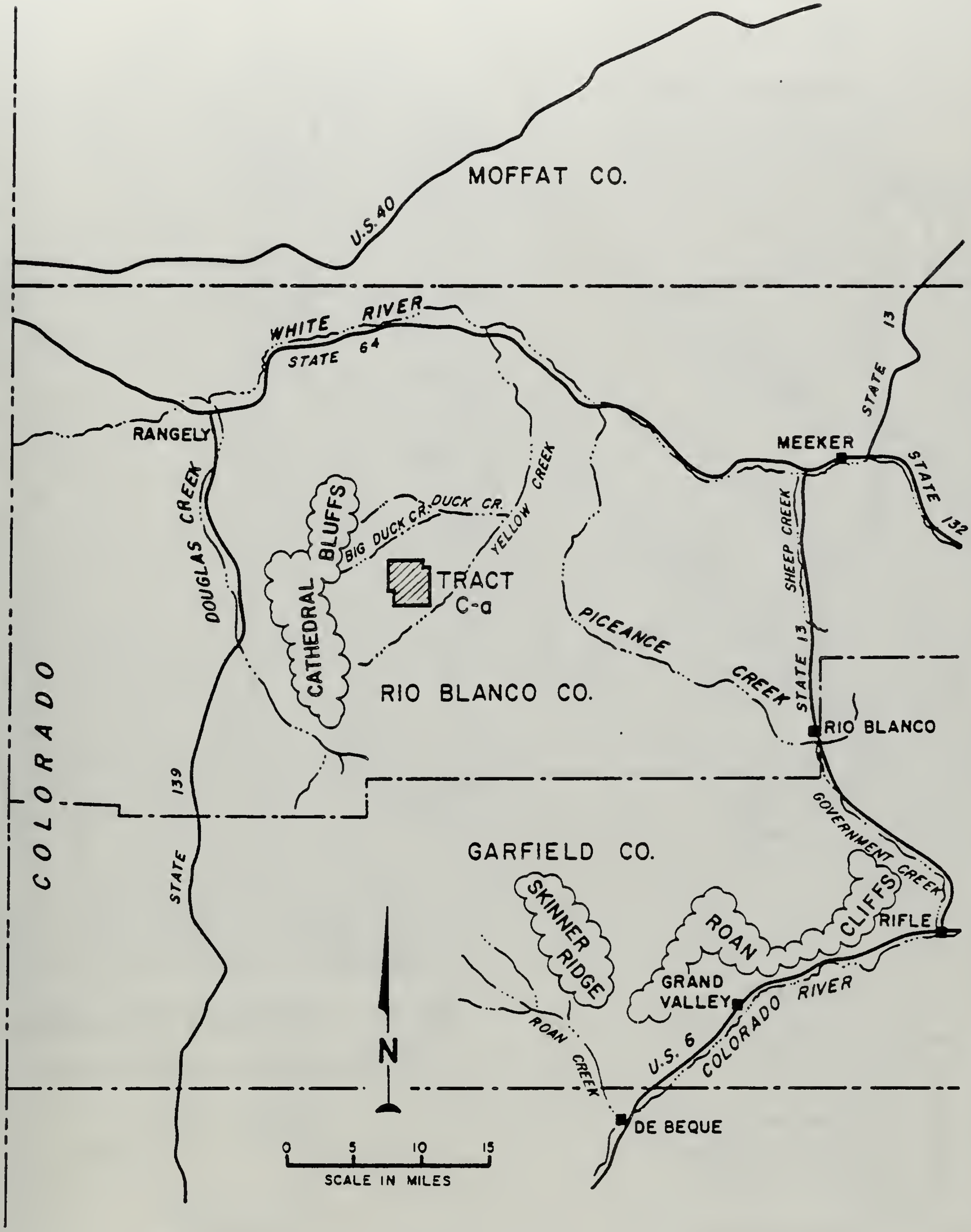
MOFFAT CO.
U.S. 40
WHITE RIVER
STATE 64
RANGELY
DOUGLAS CREEK
CATHEDRAL BLUFFS
BIG DUCK CR.
DUCK CR.
YELLOW CREEK
TRACT C-a
PICEANCE CREEK
MEEKER
STATE 13
STATE 132
SHEEP CREEK
RIO BLANCO
RIO BLANCO CO.
UTAH
COLORADO
STATE 139
GARFIELD CO.
GOVERNMENT CREEK
SKINNER RIDGE
ROAN CLIFFS
RIFLE
GRAND VALLEY
ROAN CREEK
COLORADO RIVER
U.S. 6
DE BEQUE
N
0
5
10
15
SCALE IN MILES

Figure 1

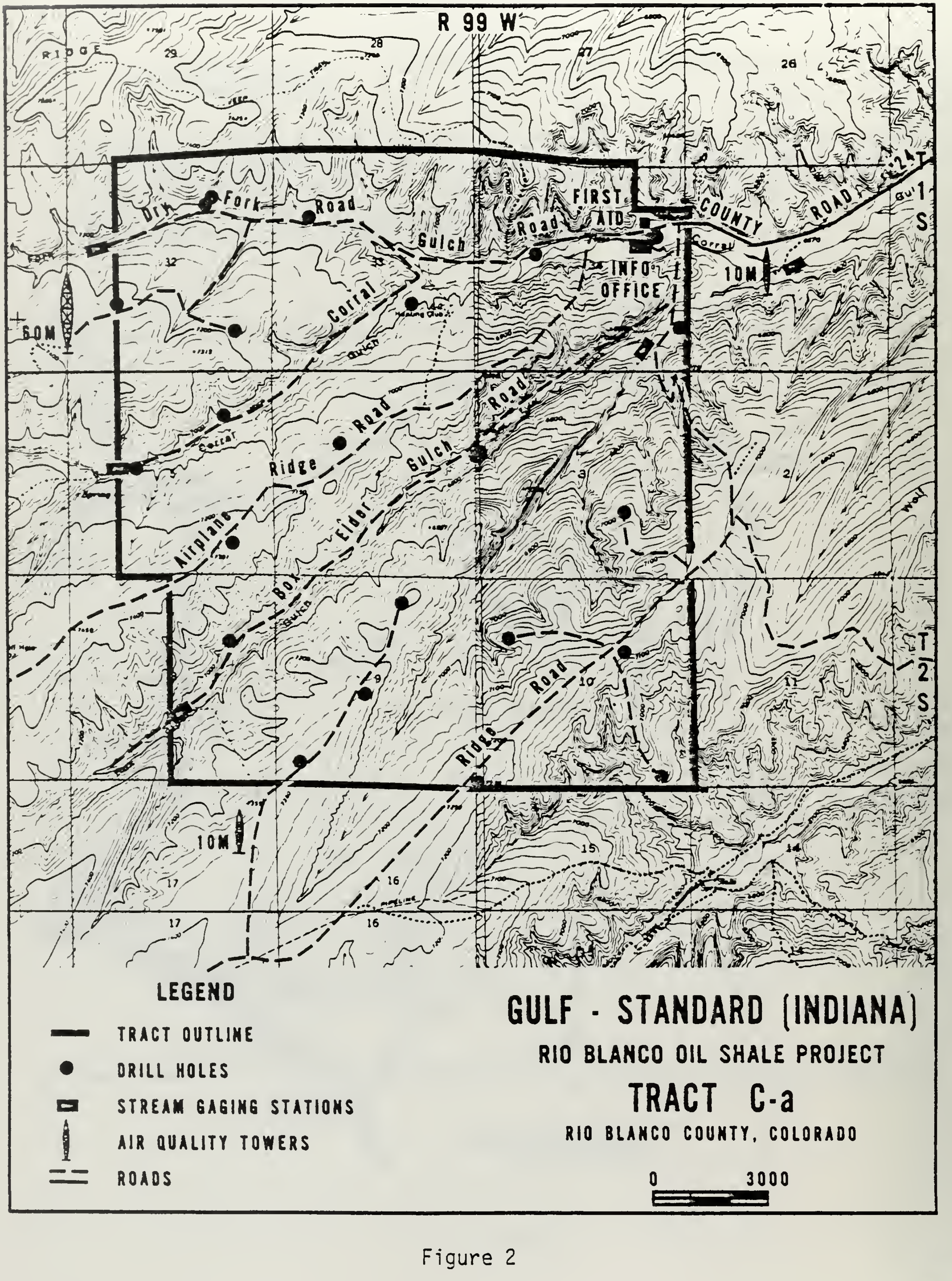
R 99 W
RIDGE
29
28
27
26
32
33
Dry Fork Road
Gulch
Road
FIRST AID
COUNTY ROAD 24
INFO OFFICE
Corral
10M
60M
Corral Gulch
Road
Corral
Ridge Road
Gulch
Box Elder Gulch
Airplane Ridge
3
2
T 1 S
T 2 S
9
10
11
Ridge Road
10M
15
14
16
17
LEGEND
TRACT OUTLINE
DRILL HOLES
STREAM GAGING STATIONS
AIR QUALITY TOWERS
ROADS
GULF - STANDARD (INDIANA)
RIO BLANCO OIL SHALE PROJECT
TRACT C-a
RIO BLANCO COUNTY, COLORADO
0
3000

Figure 2

Geotechnical Data Gathering Project

ABSTRACT

The Geotechnical Data Gathering Project initiated by RBOSP on Tract C-a in the spring and summer of 1974 provides data required for engineering studies as well as data necessary to establish baseline conditions. The data gathering consists of specific tasks conducted under the geologic program and the hydrologic program. Previous RBOSP progress reports were organized to allow reporting of the ongoing activities of each task. Presently most of the major tasks under both the geologic and the hydrologic programs have been completed and consequently, the organization of the geotechnical data gathering portion of the Progress Reports has been restructured to include only those tasks in which activity was reported during the quarterly reporting period.

Laboratory analyses being conducted under the geologic program were not completed during the quarterly reporting period of September, October, and November 1976. The USGS has been conducting quantitative analyses for nine trace elements, seven of which were analyzed for in the Rio Blanco program. The analyses is being conducted on 1,116 feet of split core from G-S 7 corehole. The USGS has also requested and received permission to analyze the G-S 7 core for extractable alumina. As of the last of November 1976 the extractable alumina analyses were forty percent complete.

Activities occurring under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. Only four of the eleven existing stream gaging stations recorded any flow during the quarterly reporting period. Precipitation through the month of September appeared similar to that of the previous year. Precipitation data is not yet available for part of the quarter, October and November 1976.

Eight of the fifteen alluvial test holes had water during the quarterly reporting period. Alluvial holes were sampled during November 1976 and water levels were measured monthly during the quarterly reporting period. The deep aquifers were also last sampled during November 1976.

1.0 GEOTECHNICAL DATA GATHERING PROJECT

The geologic and hydrologic programs which make up the Geotechnical Data Gathering Project were initiated in the spring and summer of 1974. Both the geologic program and the hydrologic program are composites of a number of tasks as shown by the work breakdown structure, Figure 1.0-1. Nearly all of the tasks under both the programs have been completed prior to this reporting period. Therefore, the Geotechnical Data Gathering Project portion of this progress report has been structured to include a discussion on only the significant activities occurring during this quarterly reporting period.

Table 1.0-1 is an index in which significant activities related to the tasks and subtasks for each of the two programs are presented in previous progress report(s).

Activity occurring under the geologic program during the quarterly reporting period of September, October, and November of 1976 involved the laboratory analyses being conducted by the United States Geological Survey (USGS) on samples split from 1,116 feet of core from the G-S 7 corehole. Other tasks under the geologic program have either been completed or discontinued.

Activities conducted under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. The revised program consists of: collection and analyses of monthly samples from stream gaging stations; continuous monitoring of flow rate, sediment discharge, temperature, and specific conductance at the stream gaging stations; monthly monitoring and recording water levels in alluvial holes; collection of water samples during the months of November, February, April, May, June, July, August, and September from the alluvial monitoring holes; collection of water samples, semi-annually, from the deep aquifer monitor holes; and measuring water levels in the deep aquifer monitor holes on a monthly basis. The last semi-annual water sampling period for the deep aquifers was in November 1976.

Figure 1.0-1

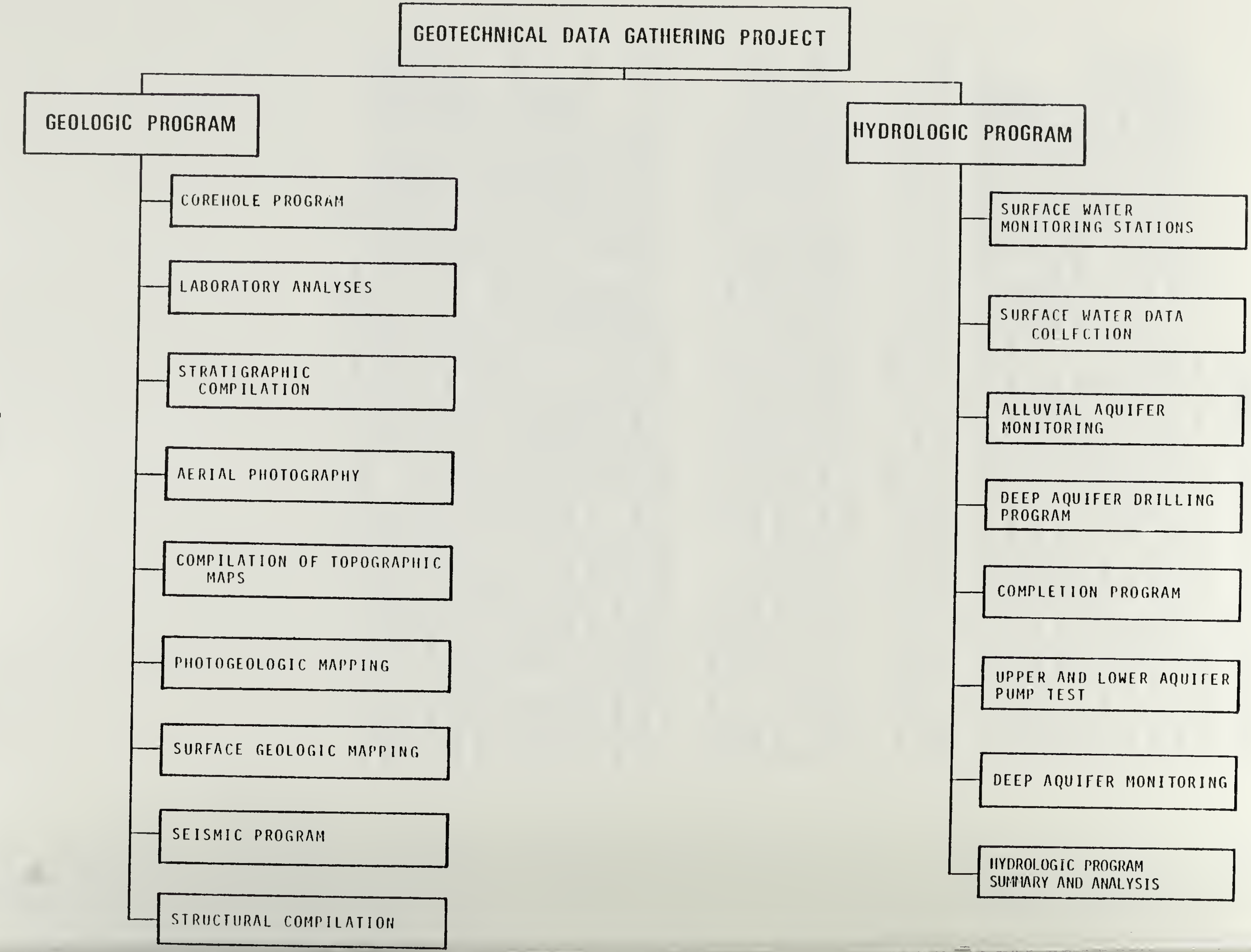
GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
STRUCTURAL COMPILATION
HYDROLOGIC PROGRAM
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DEEP AQUIFER MONITORING
HYDROLOGIC PROGRAM SUMMARY AND ANALYSIS

Table 1.0-1

INDEX OF TASKS REPORTED IN PREVIOUS
PROGRESS REPORTS

Task		Progress Report(s)
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1.2.8	Hydrologic Program Summary and Analysis	4,5,6,7,8

1.1 Geologic Program

Activity occurring under the geologic program during the quarterly reporting period (September, October and November 1976) related to laboratory analyses being conducted by the United States Geological Survey (USGS) on samples split from 1,116 feet of core from the G-S 7 corehole. Other tasks under the geologic program have been completed.

During September 1976, the USGS began laboratory analysis on 1,116 feet of G-S 7 core samples. The analysis will include quantitative analysis of the seven trace elements in the Rio Blanco program (antimony, arsenic, boron, cadmium, fluorine, mercury, and selenium) as well as two others, vanadium and molybdenum. The composite sample intervals being analyzed by the USGS are identical to those analyzed earlier for RBOSP by Core Lab to allow direct comparison of the USGS analyses with the earlier Core Lab results. Rio Blanco is retaining a split of the USGS-prepared composite samples. In the event that discreprancies exist between the Core Lab and USGS analyses Rio Blanco may elect to run additional analyses on the USGS-prepared composites in order to determine the causes of such discreprancies. As of the end of the quarterly reporting period the trace element analysis program was nearing completion. Final results of the trace element analyses will be submitted to the AOSS following completion.

Also during the month of September 1976 the USGS requested permission from Rio Blanco to run extractable alumina analyses on samples from the G-S 7 core. Rio Blanco approved the request and as of the end of November 1976, the extractable alumina analyses were nearly 40% complete. The extractable alumina analyses are to be run on one to two feet core increments rather than composite interval samples. The results of the extractable alumina analyses will be submitted to the AOSS upon completion.

1.2 Hydrologic Program

The Rio Blanco Oil Shale Project (RBOSP) hydrologic program was designed to establish Tract C-a baseline hydrologic conditions and provide the hydrologic data necessary for developmental engineering. Rio Blanco initiated surface hydrologic data collection in March of 1974. Collection of hydrologic data from deep and alluvial aquifers was initiated in December 1974. Activities occurring during this quarterly reporting period under the hydrologic program are covered in RBOSP Progress Report 9, submitted in two parts: (1) Interpretive Text, and (2) Raw Data. Only those tasks for which activity occurred during the quarter are reported in this progress report summary. Table 1.0-1 on page 1.0-3, shows in which progress report significant activity for any specific task was reported.

1.2.1 Surface Water Monitoring Stations

Rio Blanco has contracted with the Colorado River Water Conservation District to have the Water Resources Division (WRD) of the United States Geological Survey (USGS) construct and operate surface water monitoring stations. Table 1.2-1 lists each of the existing eleven stream gaging stations and the six rain gaging stations, the USGS identification number, and a description of the location of each station. Figure 1.2-1 shows the location of the stream gaging stations and the rain gaging stations in addition to alluvial aquifer monitor holes.

1.2.2 Surface Water Data Collection

Rio Blanco Oil Shale Project Progress Report 9 contains surface water data collected during the months of September, October and November 1976; however, lag time in USGS WRD data processing has caused a delay in receipt of data. The surface water data presented in this progress report are from new data received since last quarterly report. Data which has not yet been received from the USGS WRD will be submitted to the Area Oil Shale Supervisor (AOSS) following receipt, compilation, and correlation.

1.2.2.1 Stream Flow

Seven stream gaging stations, of the eleven existing, did not record measurable stream flow during the quarterly reporting period. The four stream gaging stations for which flows were reported include: Corral Gulch near west line of Tract C-a; Corral Gulch east of Tract C-a; Yellow Creek near White River; and Corral Gulch south of 84 Mesa. Figure 1.2-2 is a plot of

Table 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification Number	LOCATION
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
09306248	Upper Big Duck Creek north of 84 Mesa
09306250	Lower Big Duck Creek north of 84 Mesa
09306246	Tributary to Yellow Creek east of 84 Mesa
09306244	Corral Gulch south of 84 Mesa
	STORAGE-TYPE RAIN GAGES
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	RAINFALL INTENSITY AND RECORDING RAIN GAGES
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW1/4, NW1/4, Sec. 14 T2S, R100W

Figure 1.2-1
STREAM GAGING STATIONS,
RAIN GAGING STATIONS
AND
ALLUVIAL AQUIFER MONITORING HOLES

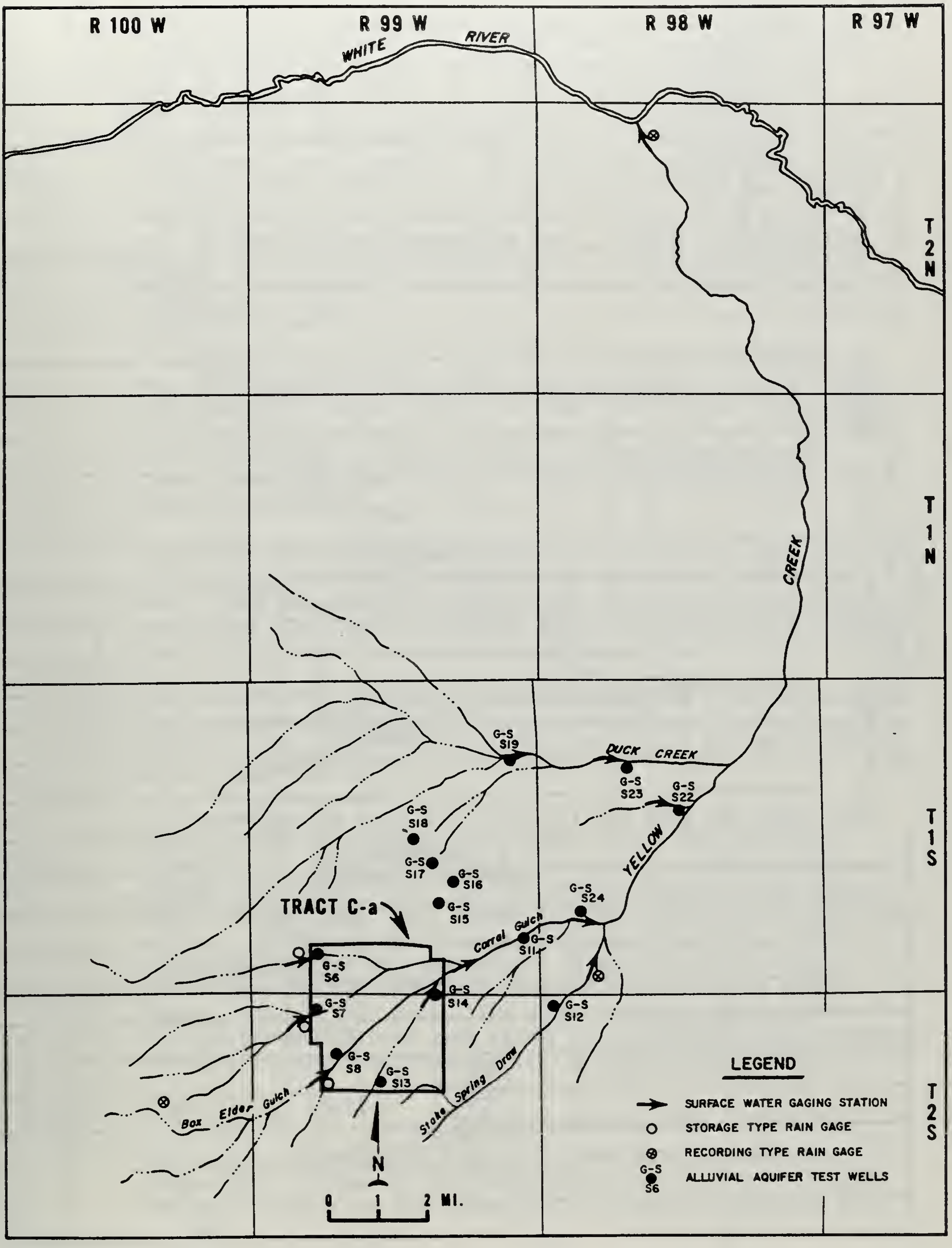
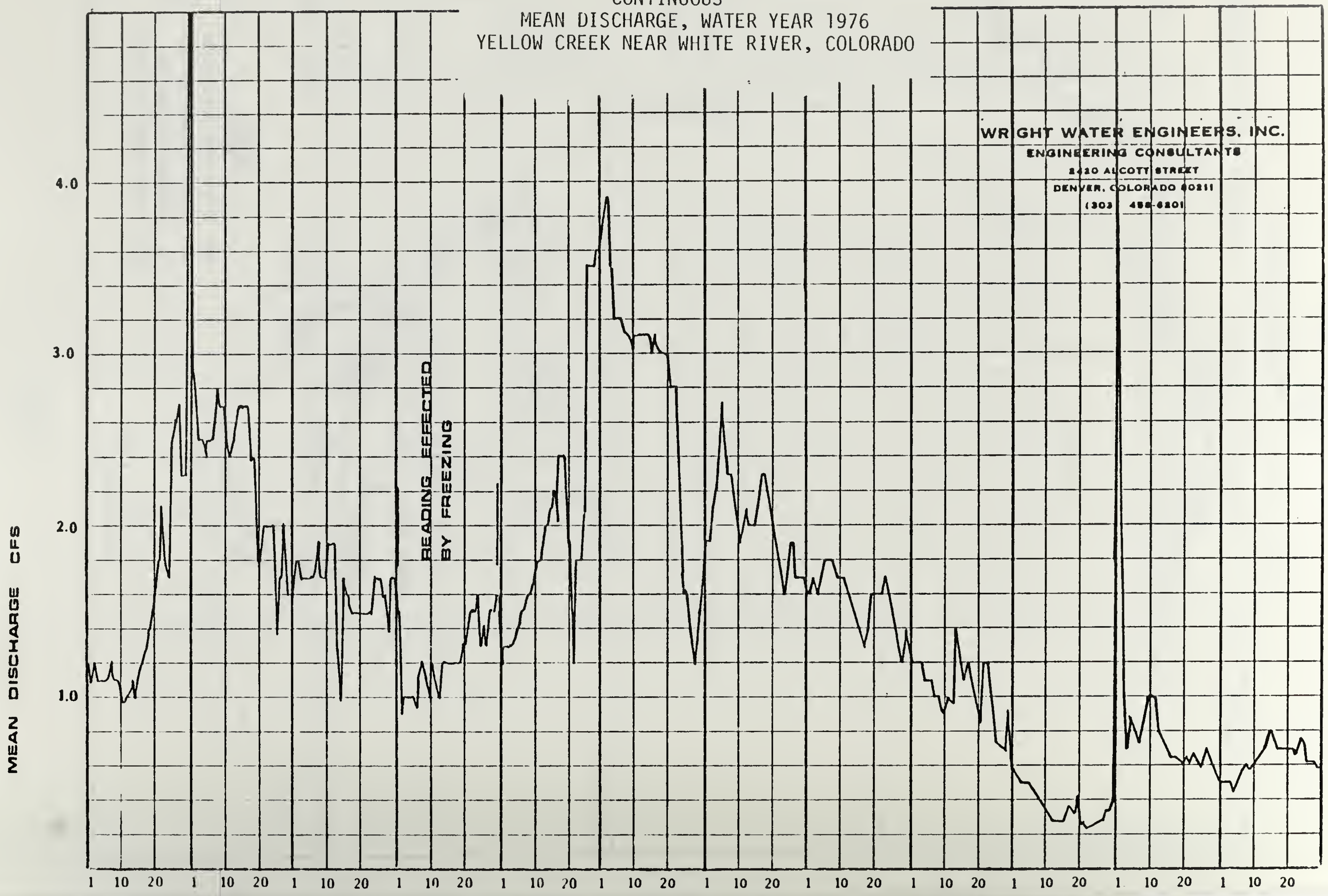


Figure 1.2-2

CONTINUOUS
MEAN DISCHARGE, WATER YEAR 1976
YELLOW CREEK NEAR WHITE RIVER, COLORADO



mean discharge in cubic feet per second (cfs) versus time for stream flow recorded at the Yellow Creek stream gaging station near the White River for the 1976 water year (October 1975 through September 1976). The Interpretive Text portion of this Progress Report contains plots of stream flows for ten of the eleven stream gaging stations for the 1976 water year. The stream gaging station on Dry Fork near west line of Tract C-a experienced only minor flow during the 1976 water year and therefore a plot of stream flows for the Dry Fork station is not included in the Interpretive Text. Table 1.2-2 shows the maximum and minimum discharges for the stream gaging stations reporting flow during the months of August, September, October and November 1976.

The USGS WRD has revised data from the previous quarterly reporting period for the stream gaging station on Corral Gulch near the west line of Tract C-a. The Interpretive Text portion of RBOSP Progress Report 9 describes the revisions by the USGS WRD. The stream discharge profile for the stream gage on Corral Gulch near west line of Tract C-a is comparable to the same period of 1975.

The stream gaging station on Corral Gulch near the east line of Tract C-a has reported flow during the entire 1976 water year. Flow has decreased from a high flow of 1.0 cubic feet per second (cfs) near the end of the previous period to a low flow of 0.29 cfs at the end of September 1976.

Flow at Corral Gulch south of 84 Mesa remained very low throughout the reporting period. Flow at this station has decreased from 0.11 cfs during the previous quarter to 0.01 cfs at the end of September 1976.

The stream gaging station on Yellow Creek near the White River reported flow during the entire water year. The profile of the discharge during the 1976 water year is similar to that of the previous water year. A high rate of flow was reported on the first of August 1976, during the previous quarterly reporting period. The precipitation gage located at the Yellow Creek stream gaging station reported 0.2 inches of rain at that time. Several high intensity thunderstorms occurred in the general area on that date. The short duration high stream flow would have to have been caused by a localized high intensity thunderstorm upstream from the Yellow Creek gaging station.

1.2.2.2 Surface Water Quality

The surface water data collection schedule is presented as Table 1.2-3. Summaries of the water quality analyses of water samples collected at the stream gaging stations reporting flow

Table 1.2-2

MAXIMUM AND MINIMUM DISCHARGE (CFS) FOR GAGING STATIONS REPORTING FLOW DURING AUGUST, SEPTEMBER, OCTOBER, NOVEMBER

USGS IDENTIFICATION NUMBER (1)	August	September	October	November
09306235				
MAX	0.26	0.24	---	---
MIN	0.20	0.18	---	---
09306242				
MAX	1.00	0.50	---	---
MIN	0.46	0.29	---	---
09306244				
MAX	0.11	0.01	---	---
MIN	0.01	0.01	---	---
09306255				
MAX	4.0	0.80	---	---
MIN	0.5	0.45	---	---

(1) See Table 1.2-1

--- Data not yet received

Table 1.2-3

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

Flow Rate
Sediment Discharge
Temperature
Specific Conductance

Periodically

Storage Rain Gages
Recording Rain Gages
Rainfall Intensity Gages

Monthly

Water Samples Analyzed For:

Alkalinity
Biological Oxygen Demand
Dissolved Organic Carbon
Boron
Calcium
Conductance
Fluoride
Magnesium
Potassium
Silica
Sodium

Sulfate
Ammonia
Bicarbonate
Carbonate
Chloride
Color
Dissolved Solids
Kjeldahl Nitrogen
Nitrate plus Nitrite
Odor
Dissolved Phosphate
Turbidity
Dissolved Oxygen

pH
Temperature
Total Phosphate
Ortho Phosphate
Suspended Organic Carbon

Quarterly

Sample and Analyze:

COD
Fecal Coliform
Pesticides
Polycyclic Aromatics
Total Coliform
Bromide
Cyanide
MBAS
Oil & Grease

Phenols
Sulfide
Radioactivity
  Gross Alpha
If >4 pci/l
Then Ra^{226}
    Natural Uranium
  Gross Beta
If >100 pci/l
Then Sr^{90}
    Ce^{137}

Ba
Be
Ge
Ga
Ni
Ti
V
Zr
Al

As

Cd
Cr
Cu
Fe
Pb
Li
Mn
Mo
Hg

Se
Sr
Zn

during the quarter are presented in Tables 1.2-4 through 1.2-7. It should be noted that these data are preliminary and subject to correction and revision. The analyses were made using both wet chemical and spectrographic methods. In some cases, the minimum detectable values vary due to either increased sensitivity of the test or because of the comparative nature of spectrographic analysis.

Generally, the values from chemical analyses of surface water samples for this quarterly reporting period conforms with previous values. Analyses of water samples from the stream gaging station on Yellow Creek near the White River still indicate that this location has the highest concentrations of many of the major constituents. Analyses of water samples taken from stream gaging stations located along the western side of Tract C-a generally indicate lower concentrations of major constituents. The station located on Corral Gulch near the west line of Tract C-a continued this trend; however, the Box Elder Gulch station did not report flow during the quarterly reporting period.

Analyses of samples from the four stations reporting flow during the period indicated that concentrations of six constituents (aluminum, ammonia, kjeldahl nitrogen, organic carbon, phosphate, and nitrite plus nitrate) vary noticeably as they have in the past. Revisions and updates of water quality data for previous reporting periods are presented in RBOSP Progress Report 9 - Interpretive Text. Water quality data which has not yet been received from the USGS WRD will be submitted to the AOSS after receipt by RBOSP.

1.2.2.3 Precipitation

There are three types of precipitation gages used by the USGS for collecting data by the USGS for RBOSP: storage gages allow precipitation to be collected and measured periodically; a recording-type gage allows the measurement of precipitation on a daily basis; and a rainfall intensity gage records the specific time of the precipitation event and measures the rate of precipitation in 5 minute increments. RBOSP Progress Report 9 - Interpretive Text contains plots of precipitation with respect to time for data collected by recording and storage type rain gages.

Table 1.2-8 is a precipitation summary showing precipitation received during this quarterly period and during August of the previous quarterly period. Unfortunately much of the precipitation data for this quarter has not yet been received from the USGS WRD. Upon receipt of the new data it will be submitted to the AOSS. Precipitation during September appeared to be

Table 1.2-4

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, U.S.G.S. 90036235
CORRAL GULCH NEAR WEST LINE TRACT C-a
YEAR 1976

ITEM	Jan.2	May 25	June 24	July 21	Aug.19	Sep. 15
Alkalinity (mg/l)	343	278	267	294	317	331
Aluminum (ug/l)*	30	---	20	---	---	20
Ammonia (NH_4) (mg/l)	.12	.03	.03	.06	.04	.01
Arsenic (ug/l)*	4	---	7	---	---	8
Barium (ug/l)*	60	---	70	---	---	---
Beryllium (ug/l)*	<3	---	<6	---	---	---
Bicarbonbate (mg/l)	418	339	325	358	387	404
Bismuth (ug/l)+	<15	---	<20	---	---	---
BOO 5 Day (mg/l)	---	---	.7	2.7	.8	---
Boron (ug/l)	80	90	110	120	100	---
Bromide (mg/l)*	---	---	.1	---	---	.1
Cadmium (ug/l)*	7	---	1	---	---	0
Calcium (mg/l)	95	65	58	69	81	88
Carbonate (mg/l)	0	0	0	0	0	0
Chloride (mg/l)	11	12	8	8.8	9.8	8.2
Chromium (ug/l)*	<15	---	10	---	---	0
COO (mg/l)*	12	---	5	---	---	21
Coliform, Fecal (Col/100 ml)*	---	---	10	---	---	---
Coliform, Total (Col/100 ml)*	---	---	---	---	---	---
Color (PCU)		8	4	25	3	3
Conductivity, Specific (umhos)	1100	1050	1050	1000	1050	1100
Cooper (ug/l)*	5	---	5	---	---	1
Cyanide (mg/l)*	.00	---	.00	---	---	0
Dissolved Oxygen (mg/l)	---	7.5	---	6.8	7.6	8.4
Fluoride (mg/l)	.3	.3	.3	.3	.3	.3
Gallium (ug/l)*	<7	---	<6	---	---	---
Germanium (ug/l)*	<40	---	<20	---	---	---
Hardness (Ca,Mg) (mg/l)	490	400	390	410	440	470
Iron (ug/l)*	30	---	30	---	---	10
Kjeldahl Nitrogen (N) (mg/l)	.69	.37	.42	.84	.59	.49
Lead (ug/l)*	< 2	---	3	---	---	1
Lithium (ug/l)*	20	---	20	---	---	20
Magnesium (mg/l)	60	58	58	58	57	60
Manganese (ug/l)*	20	---	<10	---	---	10
MBAS (mg/l)*	4.0	---	---	---	---	---
Mercury (ug/l)*	.0	---	.0	---	---	---
Molybdenum (ug/l)	40	---	23	---	---	30
Nickel (ug/l)*	<15	---	<15	---	---	---
Nitrite Plus Nitrate (N) (mg/l)	1.1	.52	.28	.53	.78	1.1
Odor (Severity)	0	0	0	1.0	0	0
Oil & Grease (mg/l)*	0	---	8	---	---	0
Organic Carbon (mg/l)						
Dissolved	14	4.6	7.4	16	7.3	9.2
Suspended	2.5	---	.3	.0	---	2.1
Total+	---	---	---	---	---	---
Pesticides (ug/l) +	0.0	---	.00	---	---	---
pH -	---	7.9	8.1	8.3	7.9	8.1
Phenols (ug/l)*	---	---	3	---	---	1
Phosphate (mg/l)						
Dissolved - PO_4	.00	.00	.06	.00	.03	.03
Ortho - P	.00	.00	.02	.00	.01	.01
Total - PO_4	.06	.03	.03	.28	.00	.37
Potassium (mg/l)	1.5	1.4	1.5	2.8	1.6	1.6
Radioactivity*						
Gross Alpha [1] (pc/l)	6.7	---	7.0	---	---	11.7
Radium 226 (pc/l)	.08	---	---	---	---	.11
Natural Uranium (ug/l)	9.8	---	10.3	---	---	17.2
Gross Beta (pc/l)						
SR^{90} (pc/l)	5.6	---	3.2	---	---	6.5
CE^{137} (pc/l)	6.8	---	3.9	---	---	7.9
Selenium (ug/l)*	2	---	4	---	---	3
Silica (mg/l)	19	20	18	22	19	21
Silver (ug/l)+	<2	---	<2	---	---	---
Sodium (mg/l)	84	85	94	93	87	85
Sodium Adsorption Ratio	1.7	1.8	2.1	2.0	1.8	1.7
Solids, Dissolved (mg/l)	793	681	702	723	730	761
Strontium (ug/l)*	1300	---	1700	---	---	2000
Sulfate (mg/l)	310	270	300	290	280	290
Sulfide (mg/l)*	0.0	---	0.5	---	---	.6
Temperature (°C)		23.0	24.5	30.0	20.0	17
Tin (ug/l)+	<15	---	<15	---	---	---
Titanium (ug/l)	<10	---	<10	---	---	---
Turbidity (JTU)	---	---	---	---	---	---
Vanadium (ug/l)*	<15	---	<15	---	---	---
Zinc (ug/l)*	10	---	0	---	---	0
Zirconium (ug/l)*	<40	---	<30	---	---	---

* Quarterly or special sampling only.

+ Required during first year baseline only.

[1] U Nat as reference.

Table 1.2-5

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, U.S.G.S. 09306242
CORRAL GULCH EAST OF TRACT C-a
YEAR 1976

ITEM	Jan.29	Feb.18	Mar.11	Aor.15	May 13	June 25	July 21	Aug. 19	Sept.1
Alkalinity (mg/l)	362	414	419	367	395	294	363	377	373
Aluminum (ug/l)*	10	10	20	---	---	20	---	---	0
Ammonia (NH$_4$) (mg/l)	.05	---	.05	.12	.13	.01	.04	.04	.04
Arsenic (ug/l)*	4	4	6	---	---	7	---	---	8
Barium (ug/l)*	---	---	60	---	---	60	---	---	---
Beryllium (ug/l)*	---	---	<4	---	---	<7	---	---	---
Bicarbonbate (mg/l)	441	505	511	448	481	358	442	460	455
Bismuth (ug/l)+	---	---	<25	---	---	<20	---	---	---
BOO 5 Day (mg/l)	---	---	---	2.6	---	---	2.0	2.2	---
Boron (ug/l)	140	120	100	150	180	90	120	110	120
Bromide (mg/l)*	---	---	.1	---	---	.1	---	---	.1
Cadmium (ug/l)*	---	---	1	---	---	10	---	---	0
Calcium (mg/l)	85	83	91	90	87	76	82	81	80
Carbonate (mg/l)	0	0	0	0	0	0	0	0	0
Chloride (mg/l)	10	9.4	12	11	12	10	11	11	11
Chromium (ug/l)*	---	---	<20	---	---	15	---	---	0
COD (mg/l)*	---	---	12	---	---	5	---	---	6
Coliform, Fecal (Col/100 ml)*	0	---	2	---	---	220	---	---	180
Coliform, Total (Col/100 ml)*	---	---	---	---	---	---	---	---	---
Color (PCU)	3	4	4	0	0	3	12	3	5
Conductivity, Specific (umhos)	1200	1300	1250	1300	1200	1150	1320	1000	1150
Copper (ug/l)*	---	---	3	---	---	6	---	---	3
Cyanide (mg/l)*	---	---	.00	---	---	.00	---	---	.00
Dissolved Oxygen (mg/l)	7.7	10.9	10.0	7.0	10.1	9.3	6.9	7.1	8.1
Fluoride (mg/l)	.4	.4	.4	.4	.4	.4	.4	.4	.4
Gallium (ug/l)*	---	---	<7	---	---	<7	---	---	---
Germanium (ug/l)*	---	---	<20	---	---	<20	---	---	---
Hardness (Ca,Mg) (mg/l)	470	460	520	510	480	430	430	450	440
Iron (ug/l)*	10	10	<20	---	---	60	---	---	10
Kjeldahl Nitrogen (N) (mg/l)	.40	.22	.11	---	.35	0	.92	.32	.49
Lead (ug/l)*	---	---	1	---	---	<15	---	---	2
Lithium (ug/l)*	---	---	20	---	---	20	---	---	20
Magnesium (mg/l)	63	60	70	69	65	57	55	60	59
Manganese (ug/l)*	---	---	40	---	---	<20	---	---	30
MBAS (mg/l)*	---	---	.1	---	---	---	---	---	---
Mercury (ug/l)*	---	---	0	---	---	0	---	---	0
Molybdenum (ug/l)	---	---	50	---	---	50	---	---	23
Nickel (ug/l)*	---	---	<20	---	---	<15	---	---	---
Nitrite Plus Nitrate (N) (mg/l)	.34	.37	.33	.32	<.32	.23	.18	.28	.54
Odor (Severity)	0	0	0	0	0	0	0	0	1
Oil & Grease (mg/l)*	---	---	0	---	---	11	---	---	.6
Organic Carbon (mg/l)									
Dissolved	14	6.7	4.2	---	---	1.7	12	.71	5.4
Suspended	.3	.3	.3	---	---	.4	1.1	1.1	.5
Total+	---	---	---	---	---	---	---	---	---
Pesticides (ug/l) +	---	---	0	---	---	---	---	---	0
pH	7.8	8.2	7.7	7.5	8.2	7.4	7.8	7.7	7.6
Phenols (ug/l)*	---	---	---	---	---	3	---	---	0
Phosphate (mg/l)									
Dissolved - PO$_4$	.03	.15	.03	.03	.03	.09	.01	.09	.06
Ortho - P	.01	.05	.01	.01	.01	.03	.01	.03	.02
Total - PO$_4$	.00	---	.12	---	.49	.03	.12	.09	.09
Potassium (mg/l)	1.5	1.4	1.7	2.4	1.5	1.4	1.7	1.7	1.3
Radioactivity*									
Gross Alpha[1] (pc/l)	---	---	<6.2	---	---	<8.4	---	---	<9.1
Radium 226 (pc/l)	---	---	.01	---	---	---	---	---	.06
Natural Uranium (ug/l)	---	---	<9.1	---	---	<12.4	---	---	<13.4
Gross Beta (pc/l)									
SR^{90} (pc/l)	---	---	3.7	---	---	2.5	---	---	3.5
CE^{137} (pc/l)	---.	---	4.6	---	---	2.9	---	---	4.2
Selenium (ug/l)*	---	---	2	---	---	3	---	---	3
Silica (mg/l)	20	20	21	22	21	19	21	20	20
Silver (ug/l)+	---	---	<2	---	---	<2	---	---	---
Sodium (mg/l)	110	100	120	120	110	100	98	110	100
Sodium Adsorption Ratio	2.2	2.0	2.3	2.3	2.2	2.1	2.1	2.3	2.1
Solids, Dissolved (mg/l)	821	787	871	837	816	714	748	772	771
Strontium (ug/l)*	2000	1800	1700	---	---	1600	---	---	1800
Sulfate (mg/l)	310	260	300	300	280	270	250	260	270
Sulfide (mg/l)*	---	---	0	---	---	.6	---	---	.6
Temperature ($^{\circ}$C)	8.5	8.5	9.0	12.0	13.0	17.0	22.0	18.0	12.0
Tin (ug/l)+	---	---	<20	---	---	<15	---	---	---
Titanium (ug/l)	---	---	<10	---	---	<10	---	---	---
Turbidity (JTU)	---	---	---	2	---	16	---	4.4	3
Vanadium (ug/l)*	---	---	<10	---	---	<15	---	---	---
Zinc (ug/l)*	---	---	10	---	---	20	---	---	10
Zirconium (ug/l)*	---	---	<30	---	---	<30	---	---	---

* Quarterly or special sampling only.

+ Required during first year baseline only.

[1] U Nat as reference.

Table 1.2-6

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, U.S.G.S. 09306244
CORRAL GULCH SOUTH OF 84 MESA
YEAR 1976

ITEM	Jan.29	Feb.18	Mar.11	May 13	June 26	July 22	Aug. 20	Sept. 16
Alkalinity (mg/l)	523	505	489	469	513	472	507	437
Aluminum (ug/l)*	10	10	<20	---	40	---	---	0
Ammonia (NH_4) (mg/l)	.06	.19	.10	.05	.00	.00	.09	0
Arsenic (ug/l)*	2	2	4	---	6	---	---	7
Barium (ug/l)*	---	---	200	---	100	---	---	---
Beryllium (ug/l)*	---	---	<5	---	<10	---	---	---
Bicarbonbate (mg/l)	638	616	596	572	626	575	618	533
Bismuth (ug/l)+	---	---	<35	---	<40	---	---	---
BOD 5-Day (mg/l)	---	---	---	3.6	---	1.65	2.30	---
Boron (ug/l)	180	160	150	40	140	210	200	220
Bromide (mg/l)*	---	---	.1	---	.2	---	---	.3
Cadmium (ug/l)*	---	---	1	---	0	---	---	0
Calcium (mg/l)	110	110	110	100	100	110	100	84
Carbonate (mg/l)	0	0	0	0	0	0	0	0
Chloride (mg/l)	18	19	16	17	18	18	19	18
Chromium (ug/l)*	---	---	<25	---	<30	---	---	0
COD (mg/l)*	---	---	26	---	6	---	---	15
Coliform, Fecal (Col/100 ml)*	---	---	2	---	58	---	---	20
Coliform, Total (Col/100 ml)*	---	---	---	---	---	---	---	---
Color (PCU)	4	15	15	5	6	18	8	8
Conductivity, Specific (umhos)	1750	1900	1700	1820	1760	1800	1880	1700
Copper (ug/l)*	---	---	2	---	7	---	---	1
Cyanide (mg/l)*	---	---	.00	---	.01	---	---	.00
Dissolved Oxygen (mg/l)	5.1	11.2	13.4	9.2	9.5	8.9	8.2	9.8
Fluoride (mg/l)	.3	.4	.3	.3	.3	.4	.3	.4
Gallium (ug/l)*	---	---	<10	---	<10	---	---	---
Germanium (ug/l)*	---	---	<30	---	<40	---	---	---
Hardness (Ca,Mg) (mg/l)	730	690	680	660	710	730	660	670
Iron (ug/l)*	20	30	<30	---	30	---	---	20
Kjeldahl Nitrogen (N) (mg/l)	.76	1.0	.96	.46	.42	.63	.35	.27
Lead (ug/l)*	---	---	< 1	---	2	---	---	1
Lithium (ug/l)*	---	---	10	---	20	---	---	10
Magnesium (mg/l)	110	100	97	100	110	110	100	110
Manganese (ug/l)*	---	---	60	---	220	---	---	20
MBAS (mg/l)*	---	---	.1	---	---	---	---	---
Mercury (ug/l)*	---	---	0	---	0	---	---	0
Molybdenum (ug/l)	---	---	60	---	60	---	---	44
Nickel (ug/l)*	---	---	<25	---	<30	---	---	---
Nitrite Plus Nitrate (N) (mg/l)	.71	.85	.68	<.04	.09	.00	.03	00
Odor (Severity)	0	0	0	0	0	1	1	1
Oil & Grease (mg/l)*	---	---	0	---	7	---	---	0
Organic Carbon (mg/l)								
Dissolved	11	13	13	7.4	9.6	39	---	9.6
Suspended	.4	.7	.3	---	---	---	---	.8
Total+	---	---	---	---	---	---	---	---
Pesticides (ug/l) +	---	---	.00	---	.00	---	---	---
pH	7.8	8.2	8.3	8.2	7.4	8.0	8.1	8.2
Phenols (ug/l)*	---	---	---	---	3	---	---	3
Phosphate (mg/l)								
Dissolved - PO_4	.06	.03	.09	.00	.09	.06	.09	.09
Ortho - P	.02	.01	.03	.00	.03	.02	.03	.03
Total - PO_4	.00	.15	.18	2.6	---	.09	.21	---
Potassium (mg/l)	2.6	2.7	3.0	2.6	2.9	2.7	3.1	2.9
Radioactivity*								
Gross Alpha [1] (pc/l)	---	---	<8.4	---	<15.4	---	---	<15.0
Radium 226 (pc/l)	---	---	.02	---	---	---	---	.05
Natural Uranium (ug/l)	---	---	<12.4	---	22.6	---	---	22
Gross Beta (pc/l)								
SR^{90} (pc/l)	---	---	10.6	---	15.2	---	---	5.7
CE^{137} (pc/l)	---	---	13.2	---	19.4	---	---	6.5
Selenium (ug/l)*	---	---	2	---	1	---	---	2
Silica (mg/l)	17	18	20	17	18	19	20	18
Silver (ug/l)+	---	---	<3	---	<4	---	---	---
Sodium (mg/l)	190	170	170	190	200	190	190	190
Sodium Adsorption Ratio	3.1	2.8	2.9	3.2	3.3	3.1	3.2	3.2
Solids, Dissolved (mg/l)	1380	1240	1210	1230	1340	1310	1300	1250
Strontium (ug/l)*	2800	2700	2300	---	2500	---	---	2600
Sulfate (mg/l)	610	510	490	520	580	580	560	560
Sulfide (mg/l)*	---	---	.2	---	.5	---	---	.5
Temperature (°C)	6.0	8.0	9.0	21.0	20.5	23.0	20.0	19.0
Tin (ug/l)+	---	---	<20	---	<30	---	---	---
Titanium (ug/l)	---	---	<20	---	<20	---	---	---
Turbidity (JTU)	---	---	---	---	---	---	---	---
Vanadium (ug/l)*	---	---	<15	---	<30	---	---	---
Zinc (ug/l)*	---	---	10	---	20	---	---	10
Zirconium (ug/l)*	---	---	<40	---	<50	---	---	---

* Quarterly or special sampling only.

+ Required during first year baseline only.

[1] U Nat as reference.

Table 1.2-7

SUMMARY WATER ANALYSIS
STREAM GAGING STATION, U.S.G.S. 09306255
YELLOW CREEK NEAR WHITE RIVER, COLORADO
YEAR 1976

ITEM	Jan.28	Feb. 26	Mar.30	Apr. 9	May 25	June 23	July 19	Aug.12	Sept. 23
Alkalinity (mg/l)	1670	1280	1530	1520	---	1660	1560	1640	1570
Aluminum (ug/l)*	20	50	110	---	---	0	---	---	30
Ammonia (NH_4) (mg/l)	.35	.30	.18	.00	.04	.01	.01	.00	.04
Arsenic (ug/l)*	4	6	---	---	---	---	---	---	10
Barium (ug/l)*	---	---	200	---	---	100	---	---	---
Beryllium (ug/l)*	---	---	<10	---	---	<20	---	---	---
Bicarbonbate (mg/l)	1460	596	1380	1580	---	1990	1410	1470	1920
Bismuth (ug/l)+	---	---	<70	---	---	<70	---	---	---
BOD 5 Day (mg/l)	---	---	---	---	5.8	1.0	2.0	---	---
Boron (ug/l)	690	580	780	680	750	820	860	790	780
Bromide (mg/l)*	---	---	.3	---	---	.2	---	---	.7
Cadmium (ug/l)*	---	---	1	---	---	0	---	---	0
Calcium (mg/l)	35	39	34	32	7.4	25	19	21	17
Carbonate (mg/l)	283	478	240	136	---	17	242	262	0
Chloride (mg/l)	156	130	140	140	140	150	160	200	150
Chromium (ug/l)*	---	---	<50	---	---	0	---	---	0
COD (mg/l)*	---	---	15	---	---	60	---	---	17
Coliform, Fecal (Col/100 ml)*	---	B 600	620	420	460	110	---	---	---
Coliform, Total (Col/100 ml)*	---	---	---	---	---	---	---	---	---
Color (PCU)	5	20	10	20	22	20	22	17	18
Conductivity, Specific (umhos)	3880	3350	3700	4000	3830	4000	3780	3900	3700
Copper (ug/l)*	---	---	6	---	---	0	---	---	2.0
Cyanide (mg/l)*	---	---	.00	---	---	.00	---	---	.00
Dissolved Oxygen (mg/l)	12.2	10.9	11.1	8.5	---	6.0	5.6	6.7	7.4
Fluoride (mg/l)	2.5	2.0	2.4	2.6	2.6	2.8	2.8	3.0	2.8
Gallium (ug/l)*	---	---	<20	---	---	<20	---	---	---
Germanium (ug/l)*	---	---	<70	---	---	<70	---	---	---
Hardness (Ca,Mg) (mg/l)	590	550	500	530	510	480	450	460	460
Iron (ug/l)*	20	20	70	---	---	80	---	---	30
Kjeldahl Nitrogen (N) (mg/l)	1.0	.90	---	.47	.44	.39	1.0	.60	.34
Lead (ug/l)*	---	---	6.0	---	---	<50	---	---	2.0
Lithium (ug/l)*	---	---	150	---	---	180	---	---	180
Magnesium (mg/l)	120	110	100	110	120	100	97	100	100
Manganese (ug/l)*	---	---	<30	---	---	0	---	---	10
MBAS (mg/l)*	---	---	.3	---	---	---	---	---	---
Mercury (ug/l)*	---	---	.0	---	---	---	---	---	0
Molybdenum (ug/l)	---	---	80	---	---	20	---	---	21
Nickel (ug/l)*	---	---	<50	---	---	<50	---	---	---
Nitrite Plus Nitrate (N) (mg/l)	1.6	1.2	1.0	.51	.01	.01	.00	.01	.04
Odor (Severity)	0	0	0	0	0	0	0	0	0
Oil & Grease (mg/l)*	---	---	0	---	---	0	---	---	0
Organic Carbon (mg/l)									
Dissolved	6.9	11	12	---	4.3	6.4	43	6.1	7.8
Suspended	---	2.4	1.1	1.0	---	.3	---	.8	1.4
Total+	---	---	---	---	---	---	---	---	---
Pesticides (ug/l) +	---	---	0.0	---	---	---	---	---	0.0
pH	8.7	8.7	8.5	8.6	8.8	8.9	8.9	8.5	8.2
Phenols (ug/l)*	---	---	---	---	---	0	---	---	1
Phosphate (mg/l)									
Dissolved - PO_4	.28	.21	.28	.09	.00	.03	.00	.03	.12
Ortho -P	.09	.07	.09	.03	.00	.01	.00	.01	.04
Total -PO_4	.49	1.4	.37	.74	.21	.06	.06	.28	---
Potassium (mg/l)	4.2	4.1	7.0	5.0	4.4	4.0	5.5	4.9	5.1
Radioactivity*									
Gross Alpha[1] (pc/l)	---	---	<81	---	---	34.7	---	---	46
Radium 226 (pc/l)	---	---	---	---	---	---	---	---	.12
Natural Uranium (ug/l)	---	---	<120	---	---	51.1	---	---	68
Gross Beta (pc/l)									
SR^{90} (pc/l)	---	---	53	---	---	< 7.4	---	---	4.5
CE^{137} (pc/l)	---	---	63	---	---	< 9.1	---	---	46.1
Selenium (ug/l)*	---	---	1	---	---	---	---	---	2
Silica (mg/l)	13	14	12	11	9.6	8.5	6.8	7.3	5.5
Silver (ug/l)+	---	---	<5	---	---	<5	---	---	---
Sodium (mg/l)	850	640	830	800	850	940	880	890	840
Sodium Adsorption Ratio	15	12	16	15	16	19	18	18	17
Solids, Dissolved (mg/l)	2760	2240	2620	2650	---	2860	2700	2730	2560
Strontium (ug/l)*	3100	3200	2700	---	---	3300	---	---	2800
Sulfate (mg/l)	570	520	570	630	620	630	590	520	490
Sulfide (mg/l)*	---	---	.6	---	---	.0	---	---	.3
Temperature (°C)	.0	1.0	1.0	16.0	27.0	17.5	28.0	24.0	22.0
Tin (ug/l)+	---	---	<50	---	---	<50	---	---	---
Titanium (ug/l)	---	---	<20	---	---	<30	---	---	---
Turbidity (JTU)	---	---	---	---	---	---	---	---	---
Vanadium (ug/l)*	---	---	<40	---	---	<50	---	---	---
Zinc (ug/l)*	---	---	0	---	---	10	---	---	10
Zirconium (ug/l)*	---	---	<100	---	---	<100	---	---	---

* Quarterly or special sampling only.

+ Required during first year baseline only.

B Coliform count non ideal.

[1] U Nat as reference

Table 1.2-8

PRECIPITATION SUMMARY
(Inches)
1976

Recording Type Rain Gage Locations	AUGUST			SEPTEMBER			OCTOBER			NOVEMBER		
	Maximum	Total	Number of Days	Maximum	Total	Number of Days	Maximum	Total	Number of Days	Maximum	Total	Number of Days
Stake Springs Draw near confluence with Corral Gulch	0.09	0.42	7	0.21	0.82	8	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Yellow Creek near White River	0.24	0.66	6	0.22	0.73	6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Cathedral Bluffs located in NW-1/4, NW-1/4, Sec. 14, T2S, R100W	0.45	1.09	6	0.28	1.40	9	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Storage Type Rain Gage Locations	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
Dry Fork near west line Trace C-a	1.44	1.04	0.33	N.A.
Box Elder Gulch near west line Tract C-a	1.35	0.89	0.41	N.A.
Corral Gulch near west line Tract C-a	0.83	0.91	0.29	.01[1/]

NA = Data not yet available

1/ = Precipitation data complete only through November 23, 1976.

about the same as the previous year for that season and each of the events were widespread. Average daily precipitation as calculated from all of the recording type rain gages for the period from September 1 to October 3, 1976 is 0.13 inches per day for each of the days experiencing precipitation.

1.2.3 Alluvial Aquifer

Fifteen alluvial aquifer test holes have been drilled on and around Tract C-a and the proposed processed shale and overburden disposal site on 84 Mesa. The alluvial aquifer holes encountering water at the time they were drilled were: G-S S-7, S-8, S-11, S-12, S-19, S-22, S-23, and S-24. Continuous water level recorders (Stevens Type F) were installed at G-S S-7, S-8, S-11, and S-12. Water samples for standard chemical analysis are collected in February, July, and November, and monthly during the snowmelt-flash flood season, April through September. A data collection schedule for alluvial holes is shown in Table 1.2-9.

1.2.3.1 Water Level Data

Water level data for the alluvial holes are summarized in Table 1.2-10. During the quarterly reporting period water levels in the alluvial tests holes declined an average of 0.91 feet; however, some alluvial test holes showed a rise in water level toward the end of the quarterly reporting period. Water level measurements from holes G-S S-8 and S-23 indicated a lowering water level throughout the quarterly reporting period. The water level in holes G-S S-7 and S-24 fell in September but rose again in November. Records of alluvial holes G-S S-11 and S-12 showed the water level rising in September and falling again in November. Hole G-S S-19 showed a rise in the water level from the previous quarter and water level records for G-S S-22 indicate virtually no change in water level during the quarterly reporting period. Plots of water level versus time are presented in the Interpretive Text portion of the quarterly report.

1.2.3.2 Water Quality

Samples for water quality analyses were collected twice during the quarterly reporting period from the eight holes that had water. Alluvial hole G-S S-19 was not sampled in September because the hole had an insufficient amount of water to allow sampling. Table 1.2-11 summarizes field measured values of conductivity and compares values measured this quarter with values measured during the previous quarter. Temperatures ranged from 6.0°C in G-S S-11 to 9.0°C in G-S S-7. During the quarterly reporting period the temperatures were lowering in all the alluvial wells. The average range of pH dropped from 6.0-6.8 to 6.0-6.4 during the quarter.

Table 1.2-9

DATA COLLECTION SCHEDULE FOR ALLUVIAL HOLES

Monthly

Water Levels Measured

February, July, November Plus Snowmelt-Flash Flood Seasons (April to September)

Water Samples Analyzed For:

- Alkalinity
- Ammonia
- Boron
- Bicarbonate
- Calcium
- Carbonate
- Chloride
- Conductance
- Dissolved Organic Carbon
- Dissolved Solids
- Fluoride
- Iron
- Magnesium
- Manganese
- Kjeldahl Nitrogen
- Nitrate plus Nitrite
- Orthophosphate
- Dissolved Phosphate
- Potassium
- Silica
- Sodium
- Sulfate
- Color
- Odor
- pH
- Temperature

February, July, November

Water Samples Analyzed for:

DO
Bromide
Cyanide
BOD
COD
Phenols
Sulfide
Radioactivity
  Gross Alpha
If >4 pci/l
Then Ra^{226}
    Natural Uranium
  Gross Beta
If >100 pci/l
Then Sr^{90}
    Ce^{137}

Ba
Be
Bi
Ge
Ga
Ni
Sr
Ti
V
Zr

Al
As
Cd
Cr
Cu
Pb
Li
Mo
Hg
Se
Sr
Zn

July or August

Samples Analyzed for:

- Fecal Coliform
- Total Coliform
- MBAS

Table 1.2-10
ALLUVIAL HOLES
COMPARATIVE WATER DEPTHS

Hole No.	June - August Depth in Feet Maximum	Minimum	Quarterly* Change	September - November Depth in Feet Maximum	Minimum	Quarterly* Change
G-S S- 6			Dry			Dry
G-S S- 7	24.57	22.17	-2.40	25.34	22.64	+1.93
G-S S- 8	35.77	29.02	-6.75	38.27	36.02	-2.50
G-S S-11	44.78	43.83	-0.03	43.13	42.79	+0.73
G-S S-12	33.71	28.11	+5.60	32.30	31.26	-3.15
G-S S-13			Dry			Dry
G-S S-14			Dry			Dry
G-S S-15			Dry			Dry
G-S S-16			Dry			Dry
G-S S-17			Dry			Dry
G-S S-18			Dry			Dry
G-S S-19	58.18	53.24	-4.94	57.11	56.04	+1.07
G-S S-22	65.91	65.06	+ .51	65.65	65.47	-0.07
G-S S-23	29.51	28.62	- .89	30.04	29.96	-0.53
G-S S-24	6.95	6.25	- .44	7.12	6.87	-0.18

---

* Quarterly change is the difference between the first measurement of the quarter and the last measurement made during the quarter. The signs (+ or -) designate whether the water level has risen (+) or fallen (-) from the first of the quarter to the end of the quarter.

Table 1.2-11

FIELD MEASURED CONDUCTIVITY

	June 21-August 29 µmhos/cm			September 24-November 14 µmhos/cm		
Hole No.	Maximum	Minimum	Quarterly* Change	Maximum	Minimum	Quarterly* Change
G-S S- 6			Dry			Dry
G-S S- 7	1180	1070	+110	1800	1100	+700
G-S S- 8	980	960	+ 20	1180	980	+200
G-S S-11	1490	1110	+220	1800	1740	+ 60
G-S S-12	1630	1210	+420	1600	1550	+ 50
G-S S-13			Dry			Dry
G-S S-14			Dry			Dry
G-S S-15			Dry			Dry
G-S S-16			Dry			Dry
G-S S-17			Dry			Dry
G-S S-18			Dry			Dry
G-S S-19	1800	1530	-270	1720	1720	None
G-S S-22	1900	1700	+200	1850	1850	None
G-S S-23	1820	1540	+280	1850	1830	+ 20
G-S S-24	1680	1440	+240	1550	1440	+110

---

*Quarterly change is the difference between the first measurement of the quarter and the last measurement made during the quarter. The signs (+ or -) designate whether the conductivity has risen (+) or fallen (-) from the first of the quarer to the end of the quarter.

The general trends of this quarter reflect the expected seasonal nature of precipitation and temperature. Plots of conductivity, pH, and temperature versus time for each of the alluvial aquifer test holes are presented in the Interpretive Text portion of the progress report. Tables 1.2-12 and 1.2-13 are summaries of the wet chemical and spectrographic analyses of samples from the alluvial aquifers test holes during the entire baseline period.

1.2.7 Deep Aquifer Monitoring

The deep aquifer monitoring program was initiated in December 1974. The program includes the measurement of water levels and collecting of water samples for analyses to determine the baseline water quality of the deep aquifers. Samples from the deep aquifers were collected monthly from March through August 1975. Following that six month period of collecting monthly samples, sample collecting was placed on a semi-annual schedule while water level measuring of the deep aquifer monitoring holes was placed on a monthly schedule. A schedule for collecting water level data and water samples for analyses is presented on Table 1.2-14. Table 1.2-15 is a completion summary for the deep aquifer monitor holes. The latest samples were collected from the monitor holes in November 1976. Deep aquifer monitor hole locations are shown on Figure 1.2-3. Monitor hole G-S 8 was found to be plugged at a depth of 630 feet as described in Progress Report 8 - Summary. Rio Blanco has submitted a request to the Area Oil Shale Supervisor for permission to plug and abandon G-S 8.

1.2.7.1 Deep Aquifer Water Levels

As described above, water levels were measured in each of the monitor holes on a monthly basis during the reporting period with the exception of the month of September. Water levels were collected in late August, mid-October, and November which is a period of less than sixty days between water level measurements. Tables 1.2-16 and 1.2-17 are tabulations of water levels for the upper and lower aquifers respectively for the period from October 1975 to November 1976.

During the quarterly reporting period water levels in the upper aquifer were found to be both rising and falling. Water levels in the southern half of Tract C-a generally were falling during the quarter. The measured water level in G-S 13, upper aquifer, was down 5.68 feet from the last measurement of the previous quarter (August 28, 1976) to the last measurement of the present period (November 14, 1976). The northern half of Tract C-a experienced a rise in the upper aquifer water level except at hole CE-702 where the water level fell 0.64 feet during the quarterly reporting period. The last measurement

Table 1.2-12

SUMMARY OF WET CHEMICAL ANALYSIS
ALLUVIAL AQUIFER
Values in mg/l
MARCH 1975 THROUGH NOVEMBER 1976

Item	Low	High	Average	# Items Averaged	Std. Dev.
Alkalinity	51.000	1505	472.237	148	126.640
Aluminum	< 0.100	1.200	0.078	18	0.282
Ammonia	0.030	6.4	0.537	107	0.883
Arsenic	< 0.010	< 0.100		118	0.001
Barium	< 1.000	< 1.900		97	
Bicarbonate	360	780	559.763	148	100.308
Boron	< 0.010	27.000	1.107	140	2.738
Cadmium	< 0.010	< 1.100	0.029	118	0.108
Calcium	28.000	240.000	99.189	148	34.892
Carbonate	< 0.010	605.000	11.837	147	52.280
Chloride	1.300	71.000	18.017	148	9.037
Chromium	< 0.010	0.200	0.008	117	0.035
Conductivity (umhos/cm)	860.000	2370.000	1549.480	134	359.286
Copper	< 0.010	8.000	0.453	118	0.035
Cyanide	< 0.010	0.200	0.003	119	0.019
Dissolved Solids	640.000	2090.000	1184.257	148	290.734
Fluoride	< 0.100	1.200	0.331	147	0.176
Gross Alpha (pci/l)	1.400	31.000	11.992	84	6.759
Gross Beta (pci/l)	1.000	35.000	13.340	30	10.009
Hardness (total)	280.000	820.000	599.776	134	140.835
Iron	< 0.050	28.000	4.940	148	5.840
Lead	0.010	13.000	0.328	117	1.203
Magnesium	3.700	150.000	87.527	148	36.541
Manganese	< 0.050	27.000	2.430	140	4.228
Mercury	< 0.001	< 0.010		118	
Nickel	0.010	0.200	0.074	96	0.057
Nitrate	< 0.100	165.000	6.467	133	15.206
pH	< 6.000	7.200	6.401	145	0.620
Phosphate	< 0.010	1.600	0.072	148	0.187
Selenium	< 0.010	< 0.100			
Silicon Dioxide	16.000	44.000	29.953	148	5.183
Silver	< 0.010	< 0.100	0.007	95	0.013
Sodium	66.000	450.000	189.000	148	60.329
Sulfate	145.000	1000.000	459.257	148	158.709
Zinc	0.100	13.000	0.621	116	1.370
Potassium	< 1.000	16.000	5.531	51	3.970
Lithium	< 0.100	0.100	0.009	22	0.029
Total Organic Carbon	2.900	292.000	45.501	104	59.319
Nitrite -N	< 0.010	0.150	6.087	44	23.425
Bromide	0.100	0.900	0.429	14	0.354
Chemical Oxygen Demand	2.500	85.000	21.577	22	17.866
Phenols	< 0.001	0.013	0.002	22	0.004
Kjeldahl N	< 0.100	8.800	2.096	52	1.907
Beryllium	< 0.020	2.500	0.612	8	0.884
Ortho Phosphate	< 0.100	1.000	0.050	46	0.160
Ammonia -N	< 0.100	5.300	0.533	30	1.044
Dissolved Organic Carbon	2.000	3.000	2.125	8	0.354
MBAS	< 0.010	< 0.010		6	
Total Coliform	< 10.000	250.000	81.429	7	91.911
Fecal Colifrom	< 10.000	40.000	8.571	7	15.736

Table 1.2-13

SUMMARY OF QUALITATIVE SPECTROGRAPHIC ANALYSIS
ALLUVIAL AQUIFER
Values in mg/l
MARCH 1975 THROUGH NOVEMBER 1976

Item	Low	High	Average	# Items Averaged	Std. Dev.
Aluminum	0.005	5.000	0.458	119	0.959
Antimony	---	---	---	0	---
Arsenic	---	---	---	0	---
Barium	0.001	0.050	0.008	51	0.013
Beryllium	0.001	0.001	0.001	5	0.000
Bismuth	---	---	---	0	---
Boron	0.010	0.500	0.352	119	0.178
Cadmium	---	---	---	0	---
Calcium	10.000	Major	10.000	6	0.000
Cerium	---	---	---	0	---
Cesium	0.001	0.001	0.001	1	0.000
Chromium	---	0.020	0.004	17	0.006
Cobalt	0.001	0.001	0.001	4	0.000
Columbium	---	---	---	0	---
Copper	0.001	0.050	0.013	118	0.014
Dysprosium	---	---	---	0	---
Erbium	---	---	---	0	---
Europium	---	---	---	0	---
Gadolinium	---	---	---	0	---
Gallium	0.001	0.010	0.004	6	0.005
Germanium	0.001	0.001	0.001	1	0.000
Gold	---	---	---	0	---
Hafnium	---	---	---	0	---
Holmium	---	---	---	0	---
Indium	---	---	---	0	---
Iridium	---	---	---	0	---
Iron	0.001	5.000	0.262	119	0.728
Lanthanum	---	---	---	0	---
Lead	0.001	0.500	0.032	50	0.079
Lithium	0.001	0.100	0.007	85	0.015
Lutetium	---	---	---	0	---
Mangesium	5.000	Major	2228.111	9	4405.680
Manganese	0.001	0.500	0.066	104	0.119
Mercury	---	---	---	0	---
Molybdenum	0.001	0.050	0.010	79	0.014
Neodymium	---	---	---	0	---
Nickel	0.001	0.070	0.011	7	0.026
Osmium	---	---	---	0	---
Palladium	---	---	---	0	---
Platinum	---	---	---	0	---
Potassium	0.010	2.000	0.547	119	0.509
Praseodymium	---	---	---	0	---
Radium (pci/l)	0.100	1.200	0.335	60	0.231
Rhenium	---	---	---	0	---
Rhodium	---	---	---	0	---
Rubidium	---	---	---	0	---
Ruthenium	---	---	---	0	---
Samarium	---	---	---	0	---
Scandium	---	---	---	0	---
Selenium	---	---	---	0	---
Silicon	2.000	Major	4.897	117	2.601
Silver	---	0.100	0.008	38	0.022
Sodium	1.000	Major	6.239	88	2.758
Strontium	0.010	0.100	0.105	116	0.085
Tantalum	---	---	---	0	---
Terbium	---	---	---	0	---
Thallium	---	---	---	0	---
Thorium	---	---	---	0	---
Thulium	---	---	---	0	---
Tin	0.001	0.001	0.001	15	0.000
Titanium	0.001	1.000	0.029	91	0.118
Tungsten	---	---	---	0	---
Uranium	---	---	---	0	---
Vanadium	0.001	0.020	0.007	10	0.008
Ytterbium	0.001	0.001	0.001	5	0.000
Yttrium	0.010	0.020	0.010	5	0.004
Zinc	0.001	0.020	0.005	44	0.006
Zirconium	0.010	0.010	0.010	2	0.000

--- Less than minimum detectable amount
Major - Concentration too large to quantify (see wet chemical analysis)

Table 1.2-14

DATA COLLECTION SCHEDULE FOR DEEP AQUIFER

Monthly

Water Levels Measure

Semi-Annually

Water Sample Analyzed For:

- Alkalinity
- Aluminium
- Ammonia
- Arsenic
- Ba
- Be
- Bi
- Bicarbonate
- Br
- B
- Dissolved Organic Carbon
- Calcium
- Carbonate
- Cd
- Chloride
- Cr
- Cu
- Cyanide
- COD
- Dissolved Solids
- Ge
- Ga
- Fluoride
- Iron
- Lead
- Li
- Mg
- Mn
- Hg
- Mo
- Ni
- Nitrate plus Nitrite
- Phenols
- Dissolved Phosphate
- Pottassium
- Se
- Silica
- Na
- Sr
- Sulfate
- Sulfide
- Ti
- V
- Zr
- Zn
- Color
- Odor
- pH
- Temperature
- Conductance

Radioactivity

- Gross Alpha
  - If >4 pci/l
  - Then Ra^{226}
  - Natural Uranium
- Gross Beta
  - If >100 pci/l
  - Then Sr^{90}
  - Ce^{137}

Table 1.2-15

DRILL HOLE COMPLETION SUMMARY
TRACT C-a AND VICINITY

Thirty On-Tract Holes

Drill Hole	Completion	Drill Hole	Completion
G-S 1	U&L	Am 4	P&A
G-S 2-3	U&L	CE - 701	Upper Aquifer Pumping Test
G-S 4-5*	U&L*	CE - 702	U&L
G-S 6	U&L	CE - 703	P&A
G-S 7	P&A	CE - 705-A	Upper Aquifer Pumping Test
G-S 8	Lower Aquifer Only	CE - 707	U&L
G-S 9	U&L	CE - 708	U&L
G-S 10	U&L	CE - 709	U&L
G-S 11	U&L	TO 1	U&L
G-S 12*	U&L*	TO 2	U&L
G-S 13	U&L	TO 3	Upper Aquifer Pumping Test
G-S 14	P&A	G-S D16	Lower Aquifer Pumping Test
G-S 15	U&L	G-S D17	Lower Aquifer Pumping Test
Am 2-A	U&L	G-S D18	Lower Aquifer Pumping Test
Am 3	U&L	G-S D19	Lower Aquifer Pumping Test

Four Off-Tract Holes

Drill Hole	Completion
G-S M1	U&L
G-S M2	U&L
G-S M3	U&L
G-S M4	U&L
G-S M5	AU

Totals

Completions in Upper and Lower Aquifers.	22
Completions in Upper Aquifer Only.	3
Completions in Lower Aquifer Only.	5
Completions in Uinta Fm. Aquifers.	1
Holes Plugged and Abandoned.	4
Total Number of Holes	35

Am = Amoco Production Company
CE = Cameron Engineers, Inc.
G-S = Gulf-Standard (Indiana)
TO = The Oil Shale Corporation
U&L = Upper and Lower Aquifer Completions
P&A = Plugged and Abandoned
AU = Aquifers, Uinta Fm.

*Holes Temporarily Modified for Upper Aquifer Pumping Test

Figure 1.2-3

LOCATION OF MONITORING HOLES

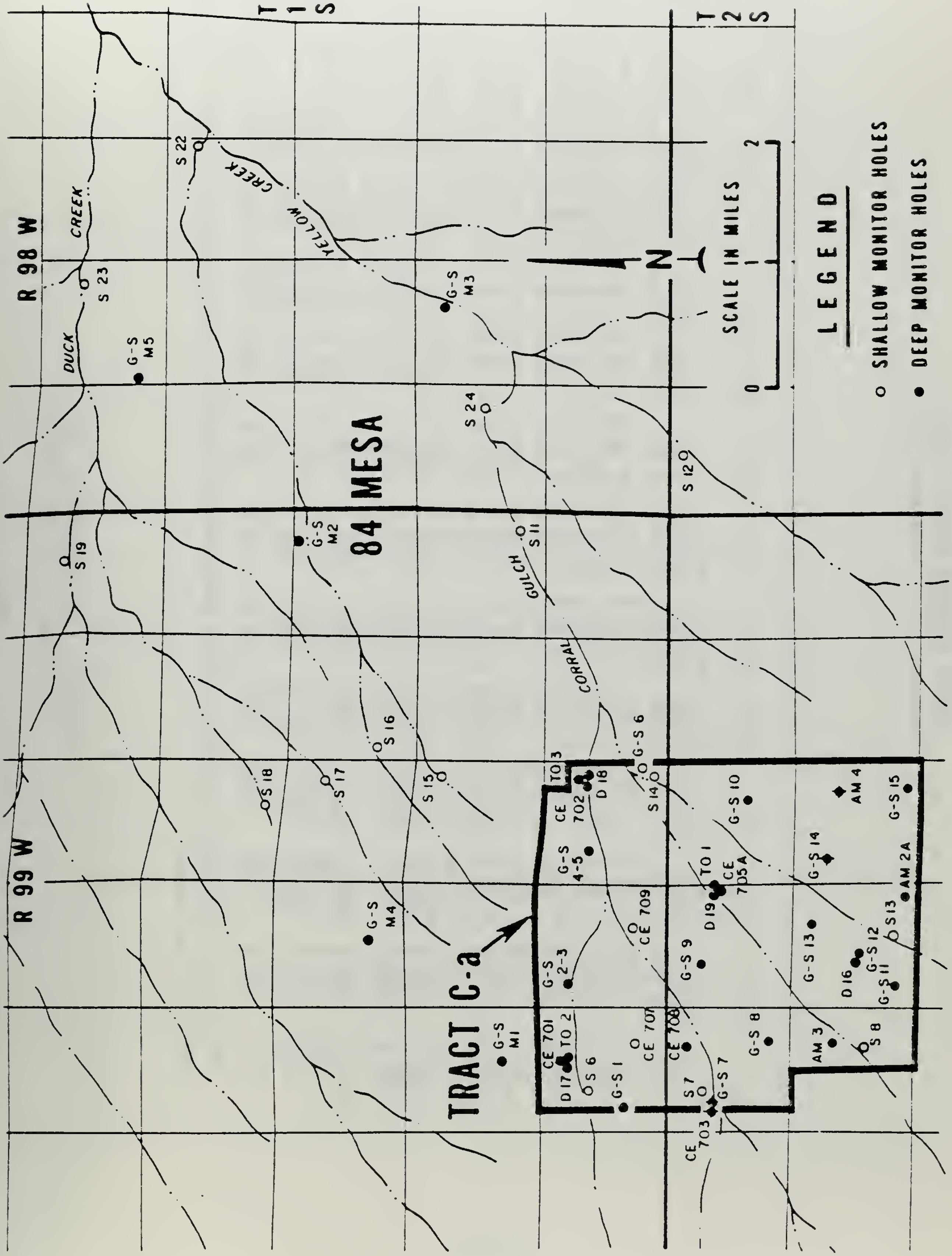


Table 1.2-16

UPPER AQUIFER WATER LEVELS
October 1975 - November 1976

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May	23 June	30 July	28 Aug.	21 Oct.	14 Nov.
AM 2A	389.45	387.63	386.41	385.17	384.34	383.19	382.50	381.85	--	379.40	379.09	378.27	378.20
AM 3	33.57	33.45	33.11	33.23	33.04	32.79	31.60	30.04	28.72	29.17	30.06	33.15	34.81
CE 702	52.40	52.30	52.39	52.64	52.65	52.80	52.66	53.02	54.50	53.38	53.70	54.19	54.34
CE 707	259.79	258.76	258.11	257.25	256.64	242.22	250.32	250.60	270.97	252.03	252.00	251.90	251.68
CE 708	48.87	50.60	49.86	51.78	51.80	51.30	47.72	44.81	46.43	44.30	46.91	48.59	49.39
CE 709	39.84	37.02	36.14	35.90	35.69	35.50	34.88	35.00	34.48	33.90	38.84*	33.88	33.71
G-S 1	244.68	245.27	245.59	246.19	246.53	246.28	244.53	243.26	242.57	241.92	242.10	243.26	243.92
G-S 2-3	103.49	102.75	102.35	102.25	101.97	100.87	100.28	99.86	99.26	99.06	99.26	98.23	98.06
G-S 4-5	75.05	74.77	74.29	74.36	74.01	73.48	72.98	72.86	73.33	72.42	72.47	72.39	73.59
G-S 6	55.62	55.54	55.42	55.50	55.45	55.27	54.95	55.22	55.10	55.20	55.61	56.02	54.14
G-S 9	311.43	312.69	316.33	319.29	319.95	321.42	320.94	317.03	316.45	317.23	319.63	318.49	319.64
G-S 10	340.35	340.11	--	339.75	339.60	339.36	339.14	339.48	339.50	339.37	339.62	339.53	339.40
G-S 11	460.35	459.67	459.00	458.76	458.40	457.72	456.95	456.42	455.46	454.99	455.35	455.91	457.02
G-S 12	388.30	387.60	386.97	386.55	386.24	385.41	384.67	382.79	382.83	381.86	382.91	383.58	384.79
G-S 13	382.62	382.19	381.68	381.72	381.45	381.04	380.97	380.41	380.11	380.12	378.47	386.06	384.15
G-S 15	274.73			273.56	273.41	272.99	272.83	272.69	274.76	272.58	272.49	272.26	272.20
G-S M-1	620.64	621.13	--	619.10	618.77	618.71	625.57	619.31	619.40	619.95	620.26	620.96	622.15
G-S M-2	231.22	230.68	229.75	228.94	228.23	225.76	255.39	225.36	224.01	221.28	223.13	222.65	221.98
G-S M-3	21.59	21.96	20.32	19.16	19.21	18.57	17.50	17.72	18.75	18.58	18.46	17.96	17.85
G-S M-4	491.80	491.95	491.56	492.04	492.08	492.25	--	492.77	492.94	493.26	491.60	493.62	493.84
G-S M-5	235.73	235.81	235.24	235.70	235.64	235.51	235.38	235.75	235.80	235.94	235.90		
TO-1	21.80	20.65	20.41	20.95	20.83	20.53	20.13	22.35	22.46	22.30	22.73	23.54	23.64
TO-2	113.36	113.36	122.96	112.93	112.73	112.57	112.18.	113.81	113.70	111.32	111.44	110.85	111.42

--Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

*Measurement believe in error.

Table 1.2-17

LOWER AQUIFER WATER LEVELS
October 1975 - November 1976

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May	23 June	30 July	28 Aug.	21 Oct.	14 Nov.
AM 2A	636.67	637.70	638.08	639.71	640.11	641.15	641.63	643.56	--	645.47	645.51	647.15	647.49
AM 3	310.40	311.27	311.56	313.34	313.73	314.65	315.31	316.90	317.67	318.80	319.50	320.55	318.82
CE 702	40.48	41.21	41.25	43.00	43.41	44.21	44.64	45.81	48.50	47.30	47.97	48.98	49.18
CE 707	567.51	568.70	569.21	570.67	571.04	572.19	572.53	--	573.00	573.81	574.78	575.77	576.22
CE 708	297.88	298.97	299.27	300.84	301.22	302.97	303.06	303.83	304.59	306.74	307.52	308.55	309.09
CE 709	154.31	155.55	154.92	157.62	158.63	158.87	159.60	160.82	160.61	162.63	163.23	164.26	164.67
G-S 1	602.65	602.43	602.13	602.13	601.70	601.64	601.58	601.91	601.76	601.67	602.36	601.94	602.02
G-S 2-3	254.92	255.98	256.61	258.03	258.32	259.43	259.81	261.05	261.79	262.79	263.66	264.46	264.89
G-S 4-5	98.31	99.55	100.09	100.57	101.95	102.89	103.40	104.46	105.12	--	105.74	107.84	105.19
G-S 6	44.06	45.88	46.26	47.72	48.12	49.01	49.45	50.65	51.29	52.41	52.89	53.81	56.19
G-S 9	513.25	514.31	514.68	516.10	516.22	517.19	517.96	517.56	518.14	518.51	519.65	520.87	521.17
G-S 10	389.69	380.81	--	392.76	393.06	394.01	394.57	396.13	396.89	398.04	396.71	399.71	396.97
G-S 11	721.76	723.02	723.36	725.51	725.53	726.65	727.18	727.63	728.46	729.60	730.46	731.42	731.96
G-S 12	649.79	649.76	650.08	651.97	652.30	653.36	653.92	655.54	656.45	659.06	656.86	659.25	659.62
G-S 13	573.82	574.98	575.36	577.08	577.34	578.39	578.96	580.40	581.58	582.80	579.40	584.46	584.91
G-S 15	363.99	365.27	365.64	367.28	367.64	368.71	369.24	370.79	371.79	372.69	373.41	374.34	374.81
G-S M-1	822.20	824.61	--	824.87	825.18	825.84	826.59	829.59	830.34	831.35	831.79	832.65	834.60
G-S M-2	354.96	355.03	354.44	355.14	354.69	354.60	354.73	353.64	355.46	355.31	355.76	355.52	353.85
G-S M-3	139.89	140.67	139.25	140.34	139.69	139.64	145.02	140.27	140.18	140.67	140.97	141.45	143.07
G-S M-4	562.50	563.58	563.95	565.32	565.65	566.55	--	--	--	571.65	568.23	568.79	569.50
TO-1	127.21	128.40	128.77	130.41	130.81	131.78	132.31	133.54	134.56	135.78	136.28	137.28	137.61
TO-2	356.68	357.83	358.31	359.62	359.95	361.01	360.93	362.93	363.57	364.64	365.30	366.39	366.86

--Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

of the previous quarter indicated the water level in the upper aquifer at CE-709 had fallen nearly five feet. Measurements during this quarterly reporting period indicated the water level had risen the five feet it had fallen during the previous quarter, therefore, the August 28 measurement is suspected to be in error.

Lower aquifer water levels were mostly stable with water level changes from measurement period to measurement period of less than two feet. An exception to this occurred in the area of holes G-S 12 and G-S 13 where the water level, measurements dropped 2.7 feet and 5.5 feet respectively. Data was reviewed in order to verify the lowering of water level in the lower aquifer of G-S 12 and G-S 13. Again, the August 28 measurements deviate from the normal trend.

1.2.7.2 Deep Aquifer Water Quality

Water samples were collected from the deep aquifers during November 1976. The analyses of samples from the upper and lower aquifer are summarized on Table 1.2-18 and 1.2-19, spectographic and wet chemical analyses respectively. More detailed data concerning analyses are contained in the Raw Data portion of the progress report.

Results from the spectographic and wet chemical analyses from the deep aquifers indicate that the water quality has not changed significantly. However, analyses of some samples indicate expected variances of the water quality in both the upper and lower aquifers. The earlier water quality was a result of the commingling of waters from the upper and lower aquifers prior to hole completion and aquifer isolation. Anamolous increases in sodium and chloride were noted in the upper aquifer at Am 2-A. The lower aquifer also at Am 2-A was anomously high in total dissolved solids (tds). The lower aquifer at Am 3 showed increases in concentration from previous trends for both sodium and bicarbonate. Samples from monitor hole CE-709 for the upper aquifer had lower values for total dissolved solids than expected. A higher than expected tds value was noted at G-S M2.

1.2.8 Hydrologic Program Summary and Analysis

Hydrologic data collected during the period September through November 1976 is reported in the Raw Data volume of RBOSP Progress Report 9. This section summarizes the data under three main categories: surface water, alluvial aquifers, and deep aquifers. It should be noted that most surface water data is only complete through the last of September 1976. The USGS WRD, as of this writing, has not completed data reduction

Table 1.2-18

SUMMARY OF WET CHEMICAL ANALYSIS MONITORING PROGRAM
UPPER AND LOWER AQUIFER
TRACT C-a AND VICINITY
Values in mg/l
MARCH 1975 TO NOVEMBER 1976

	Lower Aquifer					Upper Aquifer				
Item	Low	High	Average	# Items Averaged	Std. Dev.	Low	High	Average	# Items Averaged	Std. Dev.
Alkalinity	52.000	4500.000	975.927	123	788.577	70.000	2390.000	530.878	168	443.722
Aluminum	- 0.010	1.000	0.300	33	0.297	- 0.010	1.000	0.142	41	0.214
Ammonia	0.020	9.600	0.724	101	1.012	- 0.100	1.800	0.426	142	0.352
Arsenic	- 0.010	0.030	0.000	123	0.003	- 0.010	0.050	0.001	167	0.006
Barium	- 0.100	1.000	0.012	81	0.111	- 0.100	- 1.000	0.000	125	0.000
Bicarbonate	260.000	3310.000	1108.374	123	815.660	85.000	2760.000	615.553	168	494.654
Boron	- 0.010	9.400	1.301	123	1.530	- 0.010	4.800	0.622	168	0.939
Bromide	- 0.020	0.400	0.018	38	0.068	- 0.020	0.500	0.062	43	0.121
Chemical Oxygen Demand	- 0.100	92.000	22.941	44	18.900	- 0.100	400.000	48.233	45	75.591
Cadmium	- 0.001	0.030	0.002	123	0.006	- 0.001	0.001	0.002	168	0.009
Calcium	0.800	98.000	16.078	123	18.451	- 0.010	260.000	60.010	168	54.976
Carbonate	- 0.100	710.000	90.715	123	113.104	- 0.100	335.000	26.388	168	48.740
Chloride	- 0.100	185.000	32.997	123	33.331	- 0.100	87.000	17.857	168	16.393
Chromium	- 0.010	- 0.050	0.004	121	0.009	- 0.010	0.050	0.003	167	0.010
Conductivity (umhos/cm)	845.000	6000.000	2019.98	122	1172.06	810.000	4200.000	1591.623	167	741.923
Copper	- 0.010	0.300	0.018	123	0.050	- 0.010	0.800	0.021	168	0.098
Cyanide	- 0.010	0.080	0.002	122	0.009	- 0.010	0.100	0.002	167	0.012
Dissolved Oxygen Demand	3.000	73.000	12.143	92	8.656	1.000	50.000	10.133	129	7.208
Dissolved Solids	540.000	3640.000	1419.715	123	799.393	530.000	2850.000	1129.470	168	506.343
Fluoride	0.200	85.000	15.942	123	15.700	0.100	60.000	2.906	168	8.479
Gross Alpha (pci/l)	0.100	30.000	5.741	71	6.080	0.200	29.000	5.334	97	5.144
Gross Beta (pci/l)	3.000	830.000	50.583	36	134.942	2.000	73.000	22.464	28	18.558
Hardness (total)	20.000	690.000	165.861	101	153.023	32.000	1110.000	392.648	145	234.534
Iron	- 0.050	16.200	2.720	123	3.625	- 0.005	36.000	4.970	168	5.335
Lead	0.003	26.000	0.822	123	2.977	0.002	3.800	0.352	168	0.534
Lithium	- 0.100	1.000	0.109	44	0.197	- 0.100	1.000	0.122	45	0.280
Magnesium	1.900	140.000	30.581	123	28.439	3.500	200.000	59.421	168	37.088
Manganese	- 0.050	0.800	0.086	123	0.118	- 0.010	1.700	0.187	168	0.211
Mercury	- 0.001	- 0.010	0.000	123	0.000	- 0.001	0.045	0.000	168	0.004
Nickel	- 0.001	0.100	0.025	81	0.018	- 0.001	0.200	0.026	125	0.027
Nitrate	- 0.100	2.000	0.329	102	0.391	- 0.010	7.000	0.581	146	1.110
Nitrate -N	- 0.020	0.600	0.149	43	0.198	- 0.020	0.600	0.157	44	0.192
pH	6.000	11.000	7.27	120	0.675	6.000	8.800	6.816	165	0.463
Phenols	- 0.001	1.000	0.034	44	0.152	- 0.001	0.174	0.010	45	0.029
Phosphate	- 0.109	1.000	0.041	123	0.138	- 0.010	1.000	0.018	168	0.093
Potassium	- 1.000	19.000	4.252	44	4.193	- 1.000	11.000	2.922	45	2.459
Selenium	- 0.010	- 0.100	0.000	123	0.000	- 0.001	- 0.010	0.000	168	0.000
Silicon Dioxide	- 0.100	60.000	10.072	123	8.323	- 0.100	58.000	25.622	168	15.643
Silver	- 0.001	0.100	0.002	79	0.011	- 0.001	0.100	0.006	123	0.019
Sodium	155.000	1560.000	530.122	123	381.347	32.000	1170.000	273.167	168	221.695
Sulfate	- 4.000	740.000	163.610	123	151.638	- 4.000	900.000	357.024	168	185.697
Sulfide	- 0.010	6.500	1.036	44	1.212	0.030	49.000	3.301	46	9.714
Zinc	0.020	68.000	1.163	123	6.275	- 0.010	15.000	0.679	168	1.494

(1) Less than detectable limit given.

Table 1.2-19

SUMMARY OF SPECTROGRAPHIC ANALYSIS MONITORING PROGRAM
UPPER AND LOWER AQUIFER
TRACT C-a and VICINITY
Values in mg/l
MARCH 1975 to AUGUST 1976

	Lower Aquifer					Upper Aquifer				
Item	Low	High	Average	# Items Avg'd.	Std. Dev.	Low	High	Average	# Items Avg'd.	Std. Dev.
Aluminum	0.001	1.000	0.065	101	0.122	0.001	1.000	0.114	146	0.189
Antimony	0.200	0.200	0.200	1	0.000	---	---	---	0	---
Arsenic	---	---	---	0	---	---	---	---	0	---
Barium	0.001	0.100	0.003	14	0.004	0.001	0.010	0.003	23	0.004
Beryllium	---	---	---	0	---	---	---	---	0	---
Bismuth	---	---	---	0	---	---	---	---	0	---
Boron	0.100	0.500	0.359	99	0.165	0.100	2.000	0.366	146	0.235
Cadmium	Major	Major		0		Major	Major		0	
Calcium	0.100	Major	5.837	24	3.891	1.000	Major	7.882	17	3.533
Cerium	---	---	---	0	---	---	---	---	0	---
Cesium	---	---	---	0	---	---	---	---	0	---
Chromium	---	---	---		---	---	---	---	0	---
Cobalt	---	---	---	0	---	---	---	---	0	---
Columbium	---	---	---	0	---	---	---	---	0	---
Copper	0.001	0.020	0.005	92	0.005	0.001	0.020	0.006	136	0.005
Dysprosium	---	---	---	0	---	---	---	---	0	---
Erbium	---	---	---	0	---	---	---	---	0	---
Europium	---	---	---	0	---	---	---	---	0	---
Gadolinium	---	---	---	0	---	---	---	---	0	---
Gallium	---	---	---	0	---	---	---	---	0	---
Germanium	---	---	---	0	---	---	---	---	0	---
Gold	---	---	---	0	---	---	---	---	0	---
Hafnium	---	---	---	0	---	---	---	---	0	---
Holmium	---	---	---	0	---	---	---	---	0	---
Indium	---	---	---	0	---	---	---	---	0	---
Iridium	---	---	---	0	---	---	---	---	0	---
Iron	0.010	0.500	0.048	99	0.087	0.010	2.000	0.118	145	0.251
Lanthanum	---	---	---	0	---	---	---	---	0	---
Lead	---	0.500	0.032	30	0.096	0.001	0.200	0.020	41	0.044
Lithium	0.001	0.100	0.011	74	0.020	0.001	0.500	0.014	100	0.053
Lutetium	0.100	0.010	0.010	1	0.000	0.001	0.010	0.005	2	0.006
Magnesium	0.100	Major	3.509	23	3.471	0.100	Major	6.006	78	4.290
Manganese	0.001	0.100	0.013	83	0.025	0.001	0.200	0.020	128	0.036
Mercury	---	---	---	0	---	---	---	---	0	---
Molybdenum	0.001	0.100	0.010	52	0.018	0.001	0.500	0.017	82	0.077
Neodymium	---	---	---	0	0.000	---	---	---	0	---
Nickel	0.001	0.001	0.001	1	0.000	0.001	0.001	0.001	2	0.000
Osmium	---	---	---	0	---	---	---	---	0	---
Palladium	---	---	---	0	---	---	---	---	0	---
Platinum	---	---	---	0	---	---	---	---	0	---
Potassium	0.010	5.000	0.873	98	1.083	0.010	5.000	0.903	143	1.116
Praseodymiun	---	---	---	0	---	---	---	---	0	---
Radium (pci/l)	0.090	0.900	0.387	23	0.257	0.100	0.800	0.200	26	0.160
Rhenium	---	---	---	0	---	---	---	---	0	---
Rhodium	---	---	---	0	---	---	---	---	0	---
Rubidium	---	---	---	0	---	---	---	---	0	---
Ruthenium	---	---	---	0	---	---	---	---	0	---
Samarium	---	---	---	0	---	---	---	---	0	---
Scandium	---	---	---	0	---	---	---	---	0	---
Selenium	---	---	---	0	---	---	---	---	0	---
Silicon	<0.500	10.000	4.317	101	2.121	1.000	20.000	5.082	146	3.739
Silver	---	0.001	0.001	7	0.000	---	0.001	0.001	13	0.000
Sodium	0.100	Major	7.490	92	2.716	2.000	Major	7.385	104	2.897
Strontium	0.001	1.000	0.096	92	0.102	0.001	1.000	0.108	136	0.094
Tantalum	---	---	---	0	---	---	---	---	0	---
Terbium	---	---	---	0	---	---	---	---	0	---
Thallium	---	---	---	0	---	---	---	---	0	---
Thorium	---	---	---	0	---	---	---	---	0	---
Thulium	---	---	---	0	---	---	---	---	0	---
Tin	---	0.001	0.001	2	0.001	0.001	0.001	0.001	1	0.000
Titanium	0.001	0.010	0.000	41	0.004	0.001	0.020	0.004	79	0.004
Tungsten	---	---	---	0	---	---	---	---	0	---
Uranium	<1.500	<1.500		1	0.000	---	---	---	0	---
Vanadium	---	---	---	0	---	---	0.001	0.001	1	0.000
Ytterbium	---	---	---	0	---	---	---	---	0	---
Yttrium	---	---	---	0	---	---	---	---	0	---
Zinc	0.001	0.200	0.012	22	0.110	0.001	0.200	0.013	44	0.036
Zirconium	---	---	---	0	---	---	---	---	0	---

--- Less than minimum detectable amount
Major - Concentration too large to quantify (see wet chemical analysis)

and analyses and therefore data for part of the quarterly period (October and November 1976) is still forthcoming. The Area Oil Shale Supervisor is aware of this situation and all data will be submitted to the AOSS following receipt from the USGS WRD.

1.2.8.1 Surface Water

Seven of the eleven stream gaging stations did not report flow during the quarterly reporting period. Some of the data have not yet been received from the USGS WRD for the quarterly period and therefore the data are subject to revision. The four stream gaging stations for which flows were reported include: Corral Gulch near west line of Tract C-a; Corral Gulch east of Tract C-a; Yellow Creek near White River; and Corral Gulch south of 84 Mesa. Data from the Yellow Creek station indicate that short duration high flow was experienced during August of the previous quarterly reporting period. Verification of this high flow by other gaging stations in the area or correlation with rain gage data at the Yellow Creek stream gage which may have indicated intense precipitation responsible for the flow has not been successful. It is anticipated that the high flow was caused by a localized precipitation event upstream of the station.

The values from the chemical analyses of the surface water samples indicate that water quality conforms with that of previous reporting periods. However, six constituents (aluminum, ammonia, Kjeldahl nitrogen, organic carbon, phosphate, and nitrite plus nitrate) vary noticeably in concentration as expected.

Precipitation as indicated by the recording-type rain gages was widespread and averaged about 0.13 inches per day for each of the days that experienced precipitation. RBOSP Progress Report 9 - Interpretive Text contains plots of precipitation versus time for each of the recording and storage type rain gages.

1.2.8.2 Alluvial Aquifer

The water level in the "wet" alluvial aquifer holes has dropped an average of 0.91 feet during the quarterly reporting period. However, water levels in holes G-S S-7 and G-S S-19 were rising at the end of the quarterly period. G-S S-22 showed no change through the quarter.

Temperature has dropped in all of the "wet" alluvial holes. Field measurements of conductivity show both increases and decreases during the quarter. Alluvial holes G-S S-7, S-11, S-22, and S-24 showed decreasing conductivity whereas G-S S-8, S-12, and S-23 showed an increase. Measurements of pH in the alluvial holes were between 6.0 and 6.8. During the quarter the pH dropped in all holes with the exception of G-S S-12 where the pH rose.

Chemical constituents of the samples from the alluvial aquifers that were present in major quantities are: bicarbonate, magnesium, silicon dioxide, sodium, total dissolved solids, alkalinity, and sulfate. Calcium and magnesium were the only chemical constituents of the samples which showed any noticeable change.

1.2.8.3 Deep Aquifer Monitoring

The latest semi-annual water samples were collected from the deep aquifers in November 1976. Water levels were measured in late August, the middle of October, and November with less than 60 days between measurements. Monitor hole G-S 8 was reported to have an obstruction and be non-operational in Progress Report 8. A request to the AOSS to allow Rio Blanco to plug and abandon monitor hole G-S 8 is still pending.

Review of upper aquifer water level changes indicates that the upper aquifer water level in the northern part of the tract is still recovering from the period before aquifer isolation when open coreholes allowed the commingling of the waters from the upper and lower aquifer. In addition, the review of upper aquifer water level data suggested that one water level measurement, taken in August 1976, was erroneous. The southern part of the tract appears to be experiencing a lowering of the upper aquifer water level, which is most prominent at G-S 13. No explanation has yet been identified for the localized lowering of the water level.

Lower aquifer water level measuring also showed a lowering of water level, most prominent in the G-S 13 area, in the southern part of the tract. No explanation for such localized lowering has yet been identified.

The deep aquifer sample analyses indicates the water quality has remained relatively similar to previous analyses. Increases in sodium and chloride were noted in the upper aquifer at Am-2-A and higher total dissolved solids in the lower aquifer. Sample analyses of the lower aquifer showed an increase in sodium and chloride above average expected levels at Am 3. During the quarterly reporting period a lower than expected total dissolved solids value was noted from the upper aquifer of CE-709 while a higher than expected value of total dissolved solids was noted from the lower aquifer at G-S M2.

Environmental Baseline Data Gathering Project

ABSTRACT

This report presents the progress of Environmental Baseline Studies from September through November 1976. September and October marked the end of aquatic and terrestrial baseline studies. Atmospheric baseline studies will be concluded in February 1977 and revegetation studies will continue through 1978.

Air quality on the tract during the Fall Quarter was similar to previous quarters. Federal nonmethane hydrocarbon standards were violated 20 times, particulate standards four times. Violations of particulate standards were apparently not associated with the increased period of activity during tracer studies.

Meteorological measurements taken during the Fall Quarter agreed well with those taken during previous quarters. Mean wind speeds at all four sites were similar, during the quarter, ranging from 4.88 to 7.06 mph. The maximum wind speed recorded was 27 mph (Site 2). The maximum ambient air temperature (at 10m) for the quarter was 30.68^{0} C and was recorded at Site 4.

Precipatation measurements taken during the previous quarter at Sites 1 and 2, using both tipping bucket and shielded weighing precipitation gages indicated close agreement between the two methods. Data for that period were correlated for 36 measurements. The accuracy of the weighing gage was ±0.03 estimated to be ±0.01. Fewer comparisons were possible during the Fall Quarter (seven) resulting in only four correlations within accuracy specifications.

The greatest rate of evaporation recorded during the quarter was 0.025 (g/cm^2)/hour. Visibility on tract ranged from <1 to >100 miles. Results of the year-long Piceance Creek Basin visibility studies indicate that general visibility of the area is high. Daily mean visual ranges of >100 miles were common. Visual range was highest during the fall (1975) and lowest during the spring (1976).

Tracer studies were conducted during the quarter in conjunction with upper air studies. The results of these studies are being tabulated and will be presented as available.

Terrestrial studies conducted or completed during the quarter included phytosociological studies, small mammal trapping and laboratory analysis, night spotlight censuses, large mammal pellet group counts and terrestrial invertebrate studies.

Eight additional species of plants were collected during the Fall Quarter. Nine vegetation types were sampled and described in terms of dominant species, cover, density and strata.

Small mammals were live-trapped from 14 grids during the quarter. A total of 964 individuals representing 11 species was captured. Least chipmunks were most frequency captured, with deer mice the second most frequently encountered. No new species were encountered. Deer mice were still reproductively active during the quarter. The fall diet of deer mice consisted mostly of seeds and succulent vegetation. Animal matter was occasionally encountered.

Lagomorph surveys revealed an increase in cottontail and white-tailed jackrabbit numbers over previous quarters.

Invertebrate samples were taken in the fall by pitfall, litter D-vac, trap D-vac, beating, sweep net and Malaise traps. Data were analyzed in terms of density by feeding category and by vegetation type. Mites were frequently encountered in litter samples from all vegetation types. Mites were also common in vacuum samples, as were leafhoppers and thrips. Thrips and leafhoppers were commonly taken by aerial sampling. Malaise trap sampling resulted in the greatest variety of invertebrates. Aerial sweeps in pinyon-juniper stands yielded chickered beetles, wasps and eulopid wasps.

Eight aquatic sampling stations were dry during the sampling period. Comparison of physical and chemical data for August - September 1975 and August - September 1976 indicate that Yellow Creek water temperatures were higher in 1976 than in 1975. Turbidity was also higher in 1976, probably due to greater disturbance by cattle.

Biological samples taken during the study period included phytoplankton, zooplankton, periphyton, benthos, macrophytes and fish. Diatoms were generally the most abundant phytoplankton during both years of study. Zooplankton densities were lower in August - September 1976 than in previous quarters.

Species composition of periphyton between similar sampling periods of the two years varied somewhat. Macrophytes were rare during the fall 1976 sampling period.

Totals of 465 and 867 fish were captured during July - August, August - September 1976 sampling periods at the White River, respectively. flannelmouth suckers and speckled dace were most abundant in July - August White River samples. Speckled dace and mottled sculpin were most common in the August - September samples.

Results of sediment chemistry analyses indicate close agreement during similar sampling dates in 1975 and 1976, with the exception of aluminum, which was lower in 1976.

The soils survey on Tract C-a was completed during the quarter. Chemical and physical properties of Tract C-a soils are typical of semi-arid regions. Concentrations of macro- and micronutrients are within expected ranges except for occasionally high concentrations of nitrate or molybdenum. Trace element concentrations are within ranges considered normal for surface soils, with the exception of selenium.

The 1976 experimental revegatation plot was set up and seeded during the quarter. Compacted Tosco II processed shale was placed over one-half of the plot and covered with an artificial 3-foot soil profile before planting.

Fall 1976 Greater Sandhill Crane surveys failed to reveal the presence of cranes. Results of repeated surveys indicate that the area is not an important migratory stopover for Sandhill Cranes.

2.0 ENVIRONMENTAL BASELINE DATA GATHERING PROJECT

Multidisciplinary environmental baseline studies have been on-going in the vicinity of Tract C-a since October 1974. Studies include air quality and meteorology monitoring, terrestrial and aquatic ecology studies, and soils, revegetation and cultural resources investigations.

Each quarter, reports of progress are submitted to the Area Oil Shale Supervisor. The study period covered by this report is from September through November 1976 - the ninth report of progress.

Objectives and Methods for the environmental studies have been presented in previous reports and are not repeated herein. In sine cases data collection for a particular technical discipline was completed prior to this quarter. In such cases, the section is omitted, but referenced in the Table of Contents. Section 2.5.4, "Toxicology" has been dropped because this effort lies outside the scope of environomental studies. These studies are conducted independently and reported separately. Section 2.5.6 - "Visibility" has been dropped, and results of Basin-wide visibility studies are reported in Section 2.5 with other visibility studies.

2.1 AIR QUALITY

Air quality data are collected at four locations in the vicinity of Tract C-a. Parameters measured and locations of stations have been described in previous progress reports. Data reported herein cover the Fall 1976 quarter (1 September 1976 through 30 November 1976).

2.1.1 Parameters

Analysis of the air quality parameters measured on Tract C-a indicates that with the exception of ozone and hydrocarbons, the mean values are in the expected low background ranges. Results of the analysis are discussed and tabulated in this section.

Table 2.1-1 presents a comparison of Federal and State Standards with measurements taken from 1 September 1976 through 30 November 1976 at the RBOSP sites. The baseline data values indicated twenty exceedances of the 6-9 am nonmethane hydrocarbon standard. All of these occurrences were at Site 1 during October 1976. No other gaseous standard exceedances occurred during the Fall season.

The particulate concentrations observed during this quarter did not violate either the federal 24-hour maximum primary or the state 24-hour maximum standards. The federal secondary 24-hour standard was exceeded four times during the quarter. The state 24-hour standard was exceeded two times during the quarter. The mean value for all sites for the quarter, if continued at the same rate, would not result in an annual mean higher than the federal or state annual particulates standards.

Seasonal minimum, maximum, and mean values for all air quality parameters for Fall 1976 are presented in Table 2.1-3.

The seasonal mean values for CO, H_2S, and SO_2 shown in Table 2.1-3 are similar in value to the lower limit of detectability of the analyzers. Mean seasonal values of ozone are similar in magnitude to the maximum levels specified by the regulatory standards. The levels of these compounds appear to be background and not associated with man's activity. The hydrocarbon (both methane and total hydrocarbon) concentrations remain relatively constant throughout the day, while the ozone exhibits definite diurnal variations with a maximum at about noon and a minimum at about midnight.

Table 2.1-4 gives the particulate concentration for the quarter for each site. The frequency of sampling at Site 3 remained at the more intensive level during the Fall quarter to further define particulate concentrations. The large variation between samples and sites is expected. Considerable fugitive dust is more than likely due to activities on the tract. For example, Site 3 is not far from a well-traveled road. Although considerable airborne dust was visible during the increased activity on site

Table 2.1-1. Comparison of Federal and State air quality standards[5/] to measurements made during Fall 1976, RBOSP.

Parameter	Standard		Time Interval	Type of Standard	No. of Times Exceeded During Quarter	Site 1 Max. Measured			Site 2 Max. Measured			Site 3 Max. Measured			Site 4 Max. Measured		
						Value			Value			Value			Value		
	$\mu g/m^3$	ppm				$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time
CO	40,000	35	1 hr max.	Primary and Secondary1/	0	1514	1.322	1200 10/21	---	---	---	1467	1.281	2300 11/17	---	---	---
CO	10,000	9	8 hr max.	Primary and Secondary1/	0	1380	1.205	0500 9/5	---	---	---	1330	1.162	0800 11/19	---	---	
Nonmethane Hydrocarbon	160	0.24	3 hr max. (6-9 am only)	Primary and Secondary1/	20	335	0.513	2300 10/20	60	0.091	9/11	48	0.074	10/3	130	0.199	10/23
NO_2	100	0.05	Annual Arith. Mean	Primary and Secondary1/	NA	0[3/]	0.000[3/]	NA	---	---	---	0[3/]	0.000[3/]	NA	---	---	---
Ozone	160	0.08	1 hr max.	Primary and Secondary1/	0	88	0.045	1800 10/17	---	---	---	96	0.049	1700 9/14	---	---	---
SO_2	365	0.14	24 hr max.	Primary1/	0	5	0.002	2100 10/28	34	0.013	1400 11/17	10	0.004	1900 9/21	133	0.051	0500 9/29
SO_2	80	0.03	Annual Arith. Mean	Primary1/	NA	0[3/]	0.000[3/]	NA	3[3/]	0.001[3/]	NA	5[3/]	0.002[3/]	NA	10[3/]	0.004[3/]	NA
SO_2	1300	0.5	3 hr max.	Secondary1/	0	42	0.016	0000 10/28	10	0.004	1700 11/6	10	0.004	0900 11/10	217	0.083	2300 9/28
Particulates	260		24 hr. max.	Primary1/	0	53	NA	10/19	46	NA	10/31	281	NA	11/3	182	NA	11/3
Particulates	75		Annual Geo. Mean	Primary1/	NA	12[4/]	NA	NA	15[4/]	NA	NA	35[4/]	NA	NA	21[4/]	NA	NA
Particulates	150		24 hr max.	Secondary1/	4	53	NA	10/19	46	NA	10/31	281	NA	11/3	182	NA	11/3
Particulates	60		Annual Geo. Mean	Secondary1/	NA	12[4/]	NA	NA	15[4/]	NA	NA	35[4/]	NA	NA	21[4/]	NA	NA
Particulates	150[6/]		24 hr max.	State2/	2	41	NA	10/19	35	NA	10/31	215	NA	11/3	139	NA	11/3
Particulates	45[6/]		Annual Arith. Mean	State2/	NA	12[3/]	NA	NA	15[3/]	NA	NA	44[3/]	NA	NA	26[3/]	NA	NA

1/Environmental Protection Agency Regulations on national primary and secondary ambient air quality standards (40 CFR 50: 36 FR 22384, November 25, 1971: as amended by 38 FR 25678, September 14, 1973; 40 FR 7042, February 18, 1975).

2/Ambient air standards for metropolitan Denver air quality control region, air quality control areas, and the State of Colorado; Adopted: September 10, 1970, Effective: December 17, 1970, amended September 4, 1974, amended September 4, 1975.

3/Arithmetic mean of values measured during the quarter.

4/Geometric mean of values measured during the quarter.

5/All EPA Standards are at reference conditions of 25 C and 760 mmHg.

6/Reported at ambient temperature and pressure.

NA = Not Applicable.

-- = Not measured at this site.

Table 2.1-2. Air quality instrumentation and measurement techniques, RBOSP.

Parameter	Manufacturer	Model	Technique	Lower Detectable Limit (ppm)[1]	Accuracy ±(ppm)
SO_2/H_2S	Bendix	8700X	Flame photometric with separation column for SO_2 and H_2S	0.005	0.020
NO_x/NO	Bendix	8101-B	Chemiluminescence	0.005	0.010
THC/CH_4	Bendix	8201	Flame ionization detector with separation column for CH_4	0.005	0.10 (THC) 0.02 (CH_4)
Photochemical Oxidant (O_3)[2]	Bendix	8002	Chemiluminescence	0.001	0.004[3]
CO	Bendix	8501-5CA	Nondispersive infrared detector	0.5	0.500[3]

[1] LDL is the lowest concentration that can be differentiated from instrument noise.

[2] Photochemical oxidant corrected for interference due to nitrogen oxide and nitrogen dioxide as measured by the Federal Reference as ozone (O_3) with the chemiluminescence method.

[3] Estimated accuracy.

Table 2.1-3. Air quality parameters, seasonal summary for Fall 1976, RBOSP.[1]

Parameter	Units	Minimum	Maximum	Arithmetic Mean
SITE 1				
O_2	ppm	0.016	0.045	0.033
CO	ppm	0.000	1.322	0.317
NO	ppm	0.000	0.013	0.007
NO_x	ppm	0.000	0.012	0.007
CH_4	ppm	1.305	2.006	1.626
THC	ppm	1.373	2.262	1.790
H_2S	ppm	0.000	0.020	0.001
SO_2	ppm	0.000	0.026	0.000
Particulates	$\mu g/m^3$	1	53	12[2]
SITE 2				
CH_4	ppm	1.375	1.565	1.461
THC	ppm	1.380	1.819	1.488
H_2S	ppm	0.001	0.013	0.003
SO_2	ppm	0.001	0.008	0.001
Particulates	$\mu g/m^3$	3	46	15[2]
SITE 3				
O_3	ppm	0.004	0.048	0.028
CO	ppm	0.000	1.281	0.382
NO	ppm	0.000	0.034	0.004
NO_x	ppm	0.000	0.036	0.003
CH_4	ppm	1.273	1.615	1.469
THC	ppm	1.220	1.635	1.481
H_2S	ppm	0.001	0.010	0.003
SO_2	ppm	0.000	0.024	0.002
Particulates	$\mu g/m^3$	1	281	35[2]
SITE 4				
CH_4	ppm	1.204	1.644	1.433
THC	ppm	1.222	1.704	1.496
H_2S	ppm	0.000	0.075	0.004
SO_2	ppm	0.000	0.085	0.004
Particulates	$\mu g/m^3$	4	182	21[2]

[1] Values presented are based upon hourly averages.

[2] Geometric mean

Table 2.1-4. Particulate concentration data for Fall 1976; values are presented in μg/m^3, RBOSP.

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
September	1	1976	NA[1/]	12		7
	2				37	
	4		21	23	NA	13
	6				26[1/]	
	7		12	10		13
	8				NA	
	10		43	12	31	23
	12				15	
	13		6	11		17
	14				42	
	16		19	19	22	28
	18				16[1/]	
	19		12[1/]	26		19
	20				59	
	22		5	8	6	6
	24				1[1/]	
	25		1	3		4
	26				6	
	28		8	6	32	9
	30				21	
October	1	1976	9	15		36
	2				8	
	4		4	5	6	6
	6				19[1/]	
	7		4[1/]	10		4
	8				26	
	10		8	9	42	10
	12				27[1/]	
	13		15	17		18
	14				54	
	16		19[1/]	31	84	26
	18				57	
	19		NA[2/]	13		32
	20				95	
	22		32	38	109	25[4/]
	24				61[1/]	
	25		43[1/]	15[3/]		44
	26				21	
	28		21	12	48	18
	30				128[1/]	
	31		24	46		132

Table 2.1-4. Particulate concentration data for Fall 1976; values are presented in $\mu g/m^3$, RBOSP. (Cont.)

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
November	1	1976			210	
	3		NA	28	281	182
	5				192[1]	
	6		12	22		131
	7				70	
	9		18	44	114	105
	11				53[1]	
	12		17[1]	22		24
	13				33	
	15		11	17	38	18
	17				29[1]	
	18		8[5]	7		38
	19				36	
	21		5[1]	11	45	13
	23				47[1]	
	24		6	15		23
	25				119	
	27		20	27	26	22
	29				20[1]	
	30		53[1]	40		18

[1] Composite of particulate sizing measurements.

[2] Ran for 38 hours (84 $\mu g/m^3$).

[3] Sampler ran 1500 MST 25 October 1976 to 1499 MST 26 October 1976.

[4] Sampler ran 1524 MST 22 October 1976 to 1523 MST 23 October 1976.

[5] Sample collected 1440 MST 18 November 1976 through 1439 MST 19 November 1976.

NA - Data not available, sampling problems during the tracer studies and during the beginning of hunting season, the exceedances occurred after these events. Particulate size data by concentration and particle size range are given in Table 2.1-5. These data show that a large portion of the particulate weight is made up of particles of 0 to 0.95 μm. The values indicated by 1 μg/m are less than the estimated concentration measurable by the data collection technique.

The results of particle trace element analysis on a particulate sample taken over one 24-hour period during the quarter are given in Table 2.1-6.

Table 2.1-5. Particulate concentration by equivalent aerodynamic diameter[1] at Site 1 for Fall 1976, RBOSP.

Size Range (microns)	9/1	9/19	9/25	10/7	10/16	10/25	11/3[2]	11/12	11/21	11/30
7.2 - ∞	NA	<1	<1	<1	2	4	NA	2	<1	1
3.0 - 7.2	NA	<1	<1	<1	2	2	NA	2	<1	1
1.5 - 3.0	NA	1	<1	<1	1	2	NA	1	<1	1
0.95 - 1.5	NA	1	<1	<1	1	2	NA	1	<1	<1
0 - 0.95	NA	10	1	4	14	33	NA	11	5	50

[1] "Equivalent Aerodynamic Diameter" is defined as the size of a spherical particle of density 1 gm/cc, which has the same terminal settling velocity as the sampled particle.

[2] Data not available, sampler problems.

Table 2.1-6. High volume filter, analytical trace element results for Fall 1976, RBOSP.1/

Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m^3)
Uranium	0.04	Terbium	<0.01	Ruthenium	<0.03	Vanadium	3.9
Thorium	0.22	Gadolinium	<0.01	Molybdenum	1.3	Titanium	23
Bismuth	0.18	Europium	<0.01	Niobium	0.44	Scandium	0.04
Lead	6.3	Samarium	0.05	Zirconium	1.5	Calcium	≈2400
Thallium	<0.05	Neodymium	0.74	Yttrium	0.31	Potassium	≈1100
Mercury	<0.023	Praseodymium	0.21	Strontium	4.5	Chlorine	4.1
Gold	<0.02	Cerium	1.3	Rubidium	1.9	Sulphur	71
Platinum	<0.05	Lanthanum	0.83	Bromine	<0.01	Phosphorus	110
Iridium	<0.03	Barium	14	Selenium	0.14	Silicon	≈14000
Osmium	<0.04	Cesium	0.10	Arsenic	4.7	Aluminum	770
Rhenium	I.S.	Iodine	<0.01	Germanium	0.03	Magnesium	920
Tungsten	0.07	Tellurium	0.01	Gallium	0.08	Sodium	350
Tantalum	0.04	Antimony	<0.02	Zinc	4.9	Fluorine	81
Hafnium	<0.09	Tin	0.20	Copper	28	Oxygen	NR
Lutecium	<0.02	Indium	I.S.	Nickel	0.39	Nitrogen	NR
Ytterbium	<0.08	Cadmium	0.04	Cobalt	0.06	Carbon	NR
Thullium	0.01	Silver	0.03	Iron	850	Boron	NR
Erbium	0.01	Palladium	<0.04	Manganese	11	Beryllium	0.01
Holmium	<0.01	Rhodium	<0.01	Chromium	*	Lithium	7.2
Dysprosium	0.05						

1/Samples are collected on cellulose filters and analyzed by spark source mass spectrometry.

Notes: NR - Not Reported
*Not reported due to blank level.
I.S. - Internal Standard

2.2 METEOROLOGY

Meteorological parameters measured and locations of sites are given in previous progress reports. Upper air studies are scheduled to be done for 5 quarters of the baseline program. An upper air study was executed during the 9th quarter. Tracer diffusion studies were conducted in this quarter. Ambient noise level measurements have been completed for the first baseline monitoring year.

The baseline meteorological program is established at two lower atmospheric levels, referred to in this report as lower air studies and upper air studies. The lower air studies include data obtained from the four station network; the upper air studies involved obtaining data on the winds aloft and vertical temperature profiles. Upper air studies are performed on a seasonal basis. Upper air measurements were performed during the baseline study period concurrently with tracer studies. Studies which provide useful information, but do not fall into these categories are: precipitation, evaporation, solar radiation, noise, snow course, visibility, and tracer studies (discussed under Miscellaneous, Section 2.2.3).

The Fall 1976 quarter (season), as used in this section, is defined as 1 September 1976 through 30 November 1976.

2.2.1 Lower Air Studies

The 1976 Fall seasonal summaries of the minimum, maximum, and mean values of the meteorological parameters measured at each site are presented in Table 2.2-1. The composite hour, as illustrated in Figures 2.2-1 through 2.2-6, is the mean of the data taken during a particular hour of the day for all days of the period indicated. A composite day defines the minimum, maximum, and mean values for 24 composite hours of a month. The minimum and maximum listed are the individual hourly averages which are greater than or less than all other hourly averages.

The prevailing 10-m level wind at Site 1 was from the west-southwest and the prevailing 10-m level wind at Site 2 was from the southwest during Fall 1976.

The mean wind speeds were 6.46 mph at Site 1 and 7.06 mph at Site 2. Although Sites 1 and 2 are at about the same elevation (7,400 feet above MSL), the local terrain at Site 2 is relatively flatter than at Site 1. The Site 2 monitoring location is the highest point within a radius of approximately 1 km. The 10-m level of the main meteorological tower at Site 1 is approximately 50 m lower than the elevation of several knolls within several hundred meters. The increased terrain influence at Site 1 is probably responsible for the lower mean wind speed.

Table 2.2-1. Meteorological parameters, seasonal summary for Fall 1976, RBOSP.[1]

Parameter	Units	Minimum	Maximum	Mean
		Site 1		
Wind Speed (10 m)	mph	0.87	21.81	6.46
Wind Speed (30 m)	mph	0.94	26.30	7.43
Wind Speed (60 m)	mph	0.92	31.18	8.26
Wind Direction Sigma (10 m)	degrees	0.39	34.52	11.43
Air Temperature (10 m)	C	-21.70	26.83	7.94
Air Temperature (30 m)	C	-21.30	26.46	7.94
Temperature Difference (60 to 10 m)	C	-2.37	1.32	0.08
Relative Humidity (10 m)	%	12.13	80.95	27.11
		Site 2		
Wind Speed (10 m)	mph	0.69	27.29	7.06
Air Temperature (10 m)	C	-22.20	26.30	7.60
		Site 3		
Wind Speed (10 m)	mph	0.55	24.83	6.40
Air Temperature (10 m)	C	-25.30	28.79	5.79
		Site 4		
Wind Speed (10 m)	mph	0.75	22.52	4.88
Air Temperature (10 m)	C	-31.50	30.68	4.08

[1] Values presented are based on hourly averages.

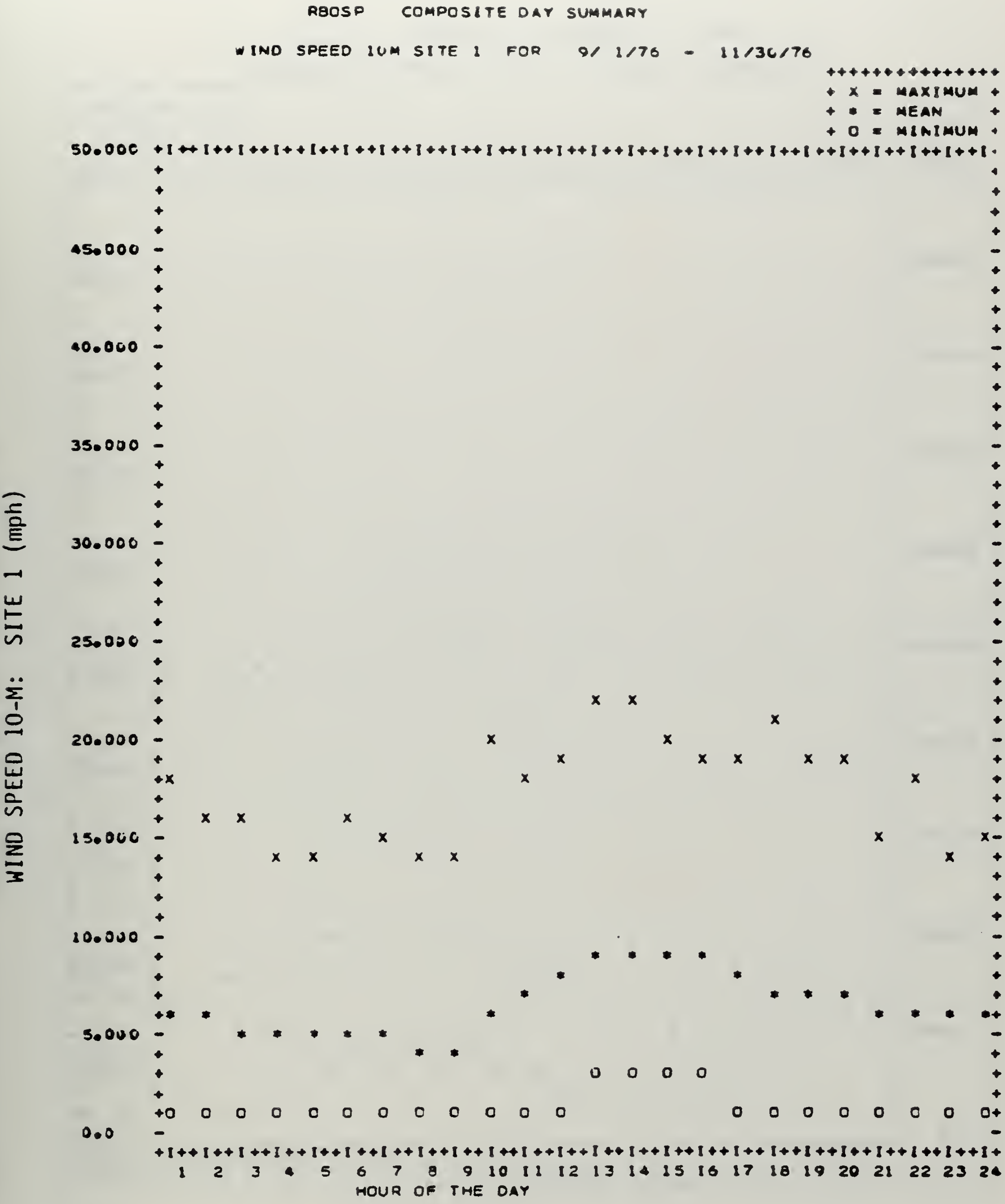


Figure 2.2-1. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

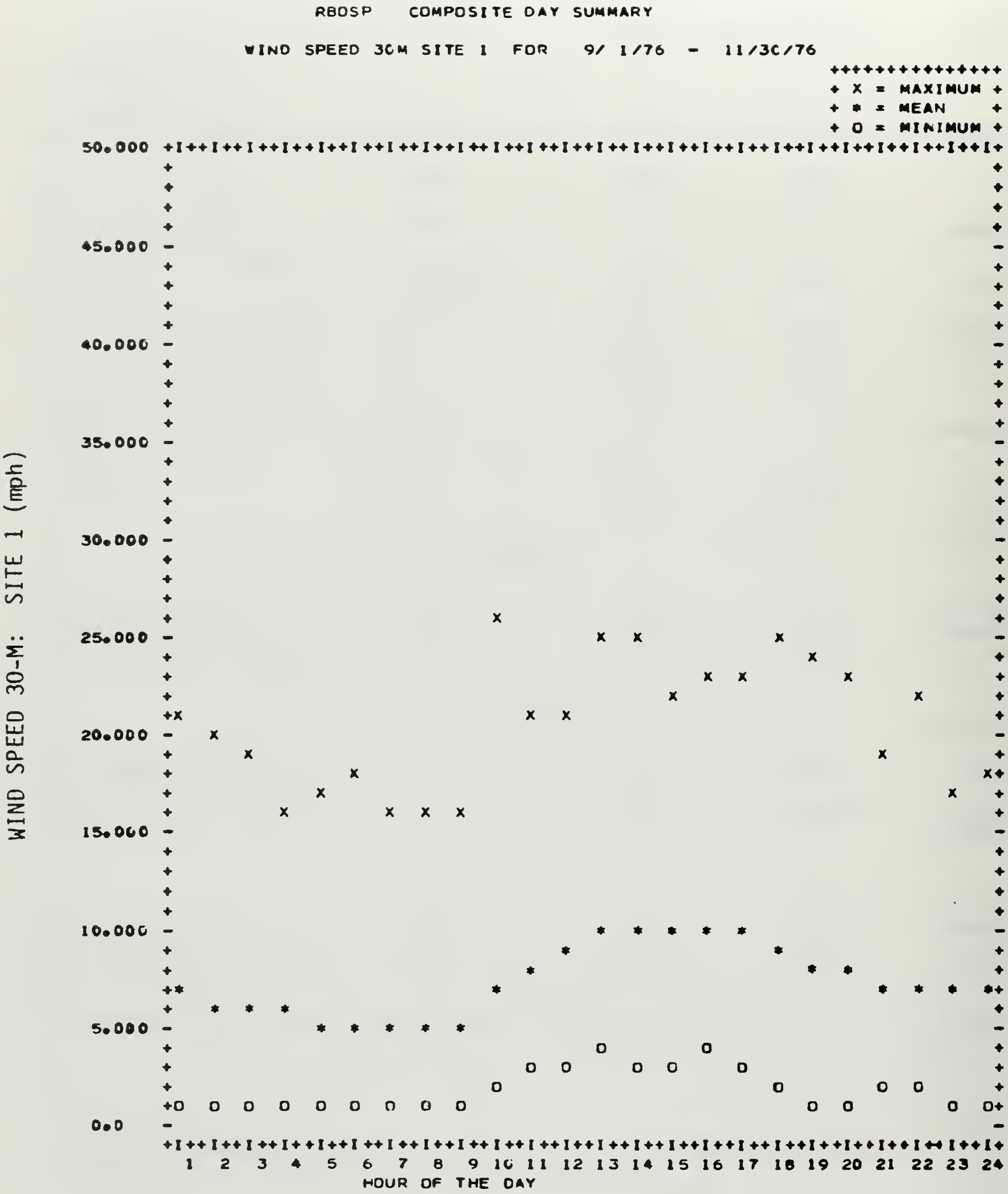


Figure 2.2-2. Wind speed, 30-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

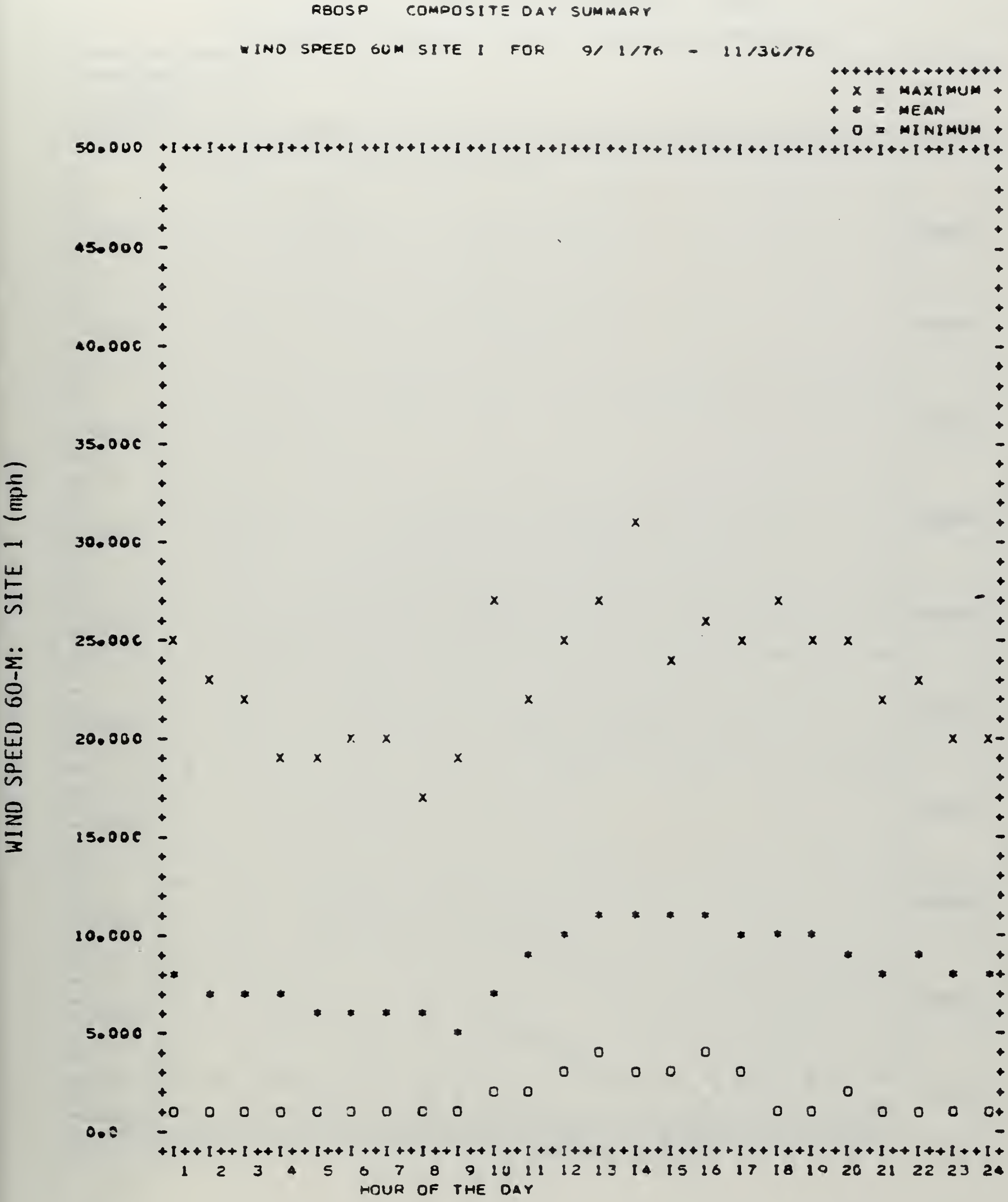


Figure 2.2-3. Wind speed, 60-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

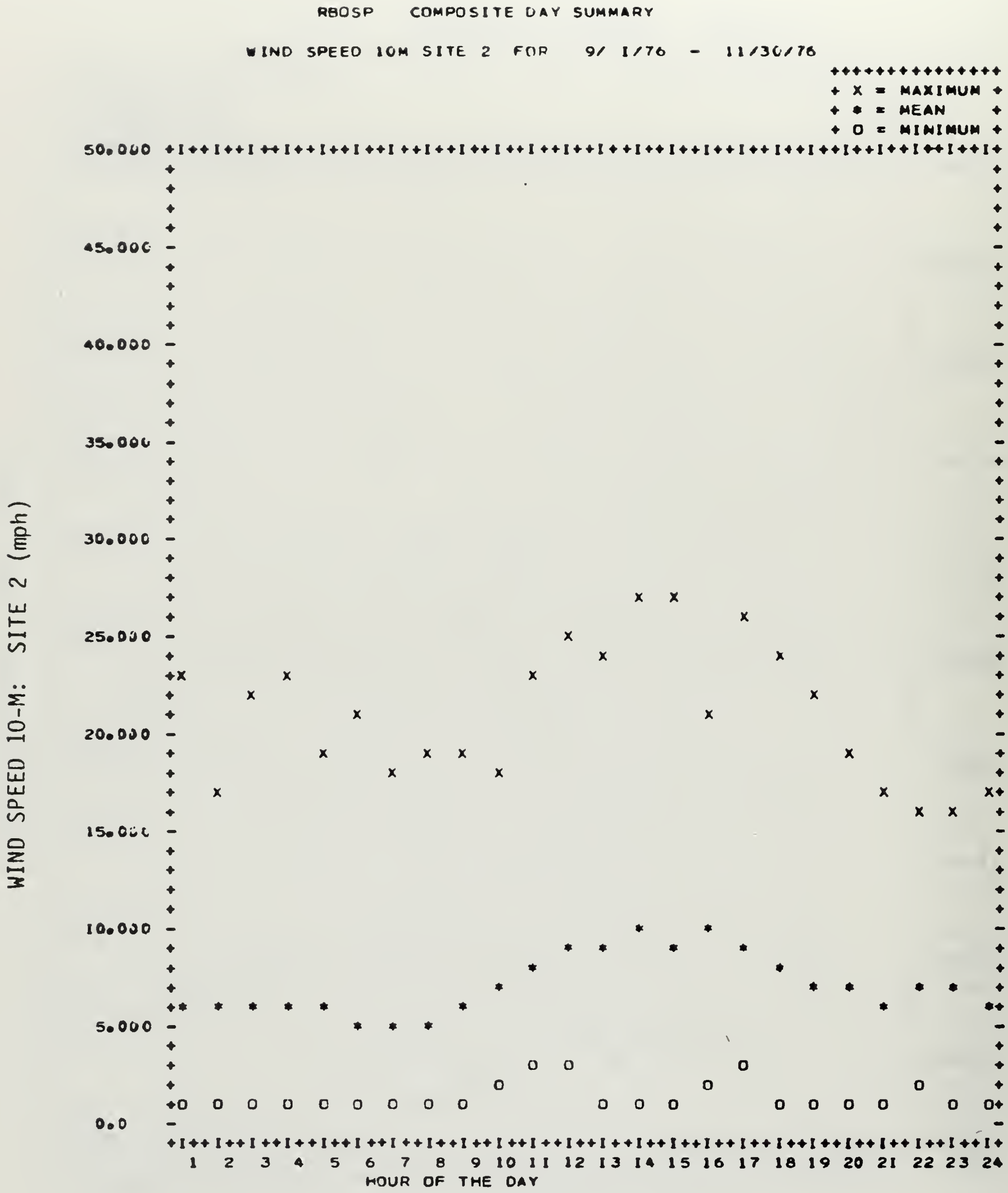


Figure 2.2-4. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 2, RBOSP.

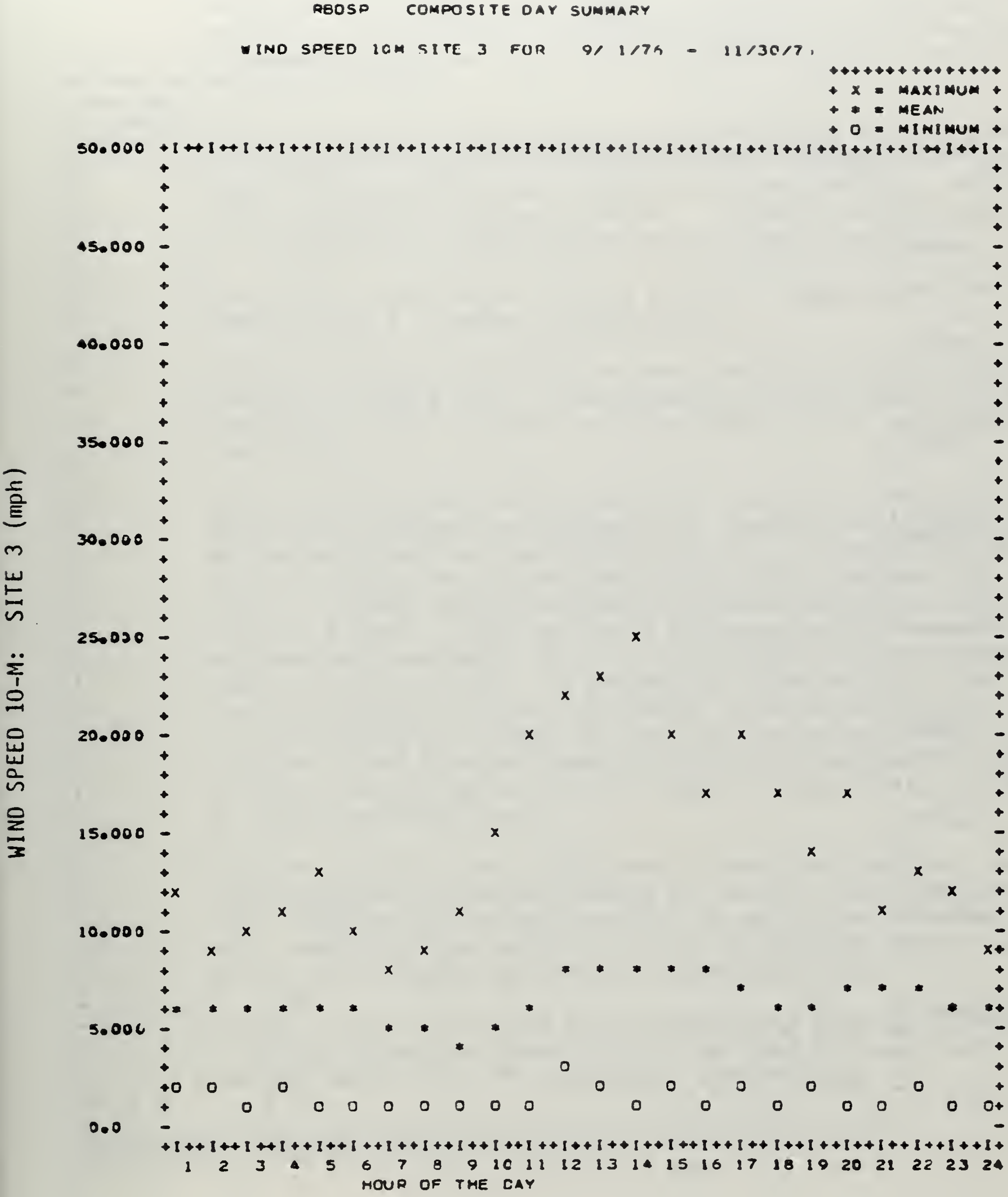


Figure 2.2-5. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 3, RBOSP.

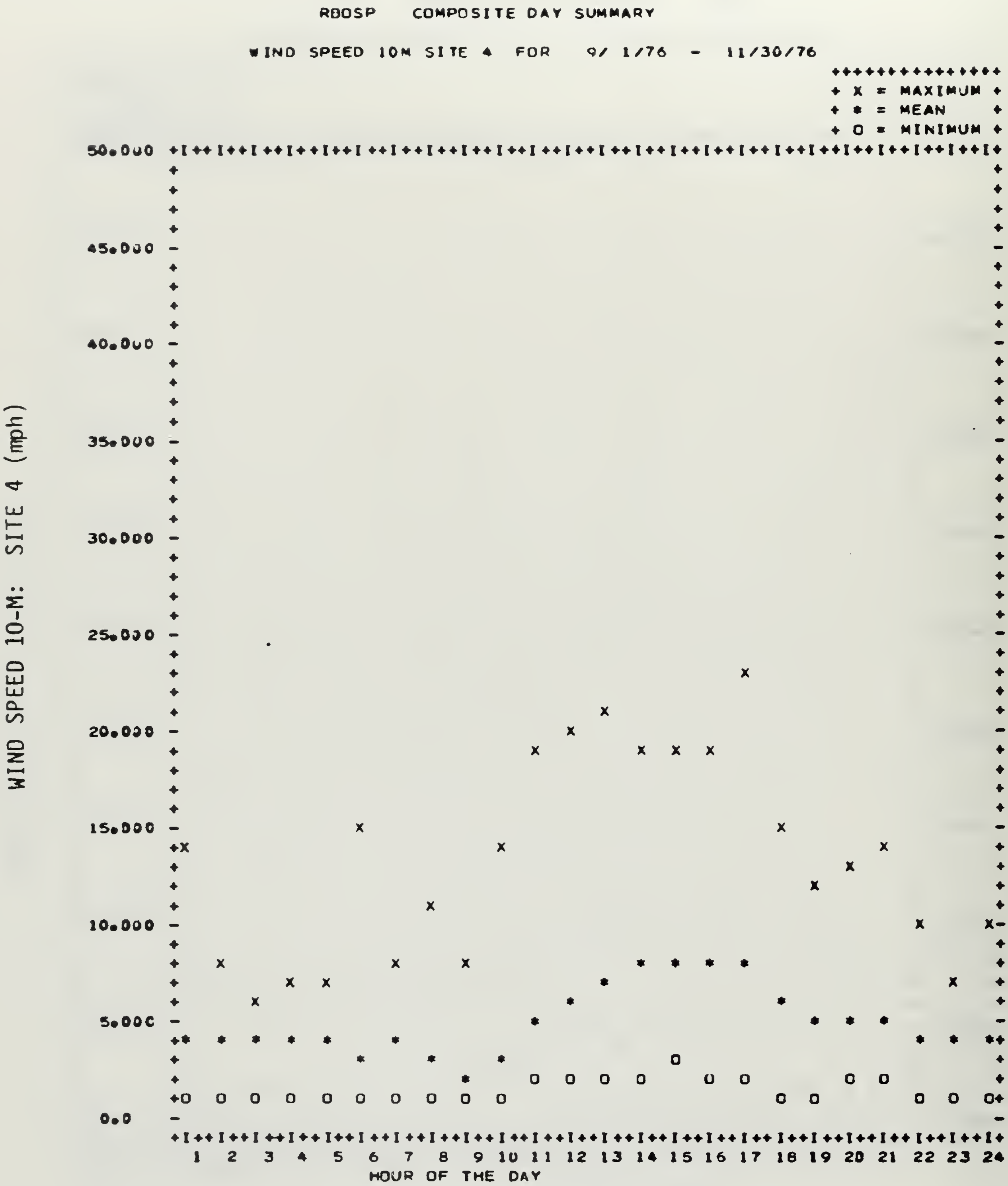


Figure 2.2-6. Wind speed, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 4, RBOSP.

Mean wind speeds at Sites 3 and 4 for the Fall 1976 period were 6.40 and 4.88 mph, respectively. Sites 3 and 4, below plateau levels, are situated in the approximate centers of Corral Gulch and Yellow Creek Gulch at elevations of 6,570 and 6,280 feet above MSL. Corral Gulch is oriented in a west to east direction. Yellow Creek Gulch is oriented in a south-southwest to north-northwest direction.

The diurnal variation of mean wind speed for each site is shown in Figures 2.2-1 to 2.2-6. Mean wind speeds average 4 to 7 mph higher during daytime hours than during nighttime hours, with Site 1 showing the smaller variation. The 60-m level has about a 7-mph higher wind speed during the day than at night.

The diurnal variation of the wind direction sigma at the 10-m level at Site 1 is shown in Figure 2.2-7.

Wind rose data for Fall 1976 are presented for all four monitoring stations in Figure 2.2-8. The percentage of occurrence of each wind class can be obtained from the number scale on each wind rose plot.

Wind rose data (10-m level) from Sites 1 and 2 are comparable. The reduced frequency of occurrence of southwest winds relative to south-southwest and west-southwest winds is probably caused by the influence from a small knoll about 200 m southwest of Site 1. Extreme terrain-induced wind channeling effects exist at Sites 3 and 4. Winds at Site 3 are predominantly from the west and west-southwest, which is in agreement with the westerly course of Corral Gulch. The predominant winds at Site 4 are from the southwest and west-southwest, corresponding closely to the orientation of Stake Springs Draw and Yellow Creek. In addition to the terrain-induced channeling of the gradient winds at Sites 3 and 4, valley drainage flows contributed significantly to the direction of winds.

The term gradient wind is used here to describe wind flows resulting from a pressure difference between two points at the same elevation. The term valley drainage flow is used to describe the winds resulting from radiative cooling of the near surface layers of air which produces a subsiding, down-slope flow.

A least squares fit to the mean seasonal wind speed as a function of height at the 60-m tower (Site 1) was done to investigate the applicability of the logarithmic wind profiles:

$$\overline{u} = \frac{u^*}{K} \ln \frac{Z}{Z_o}$$

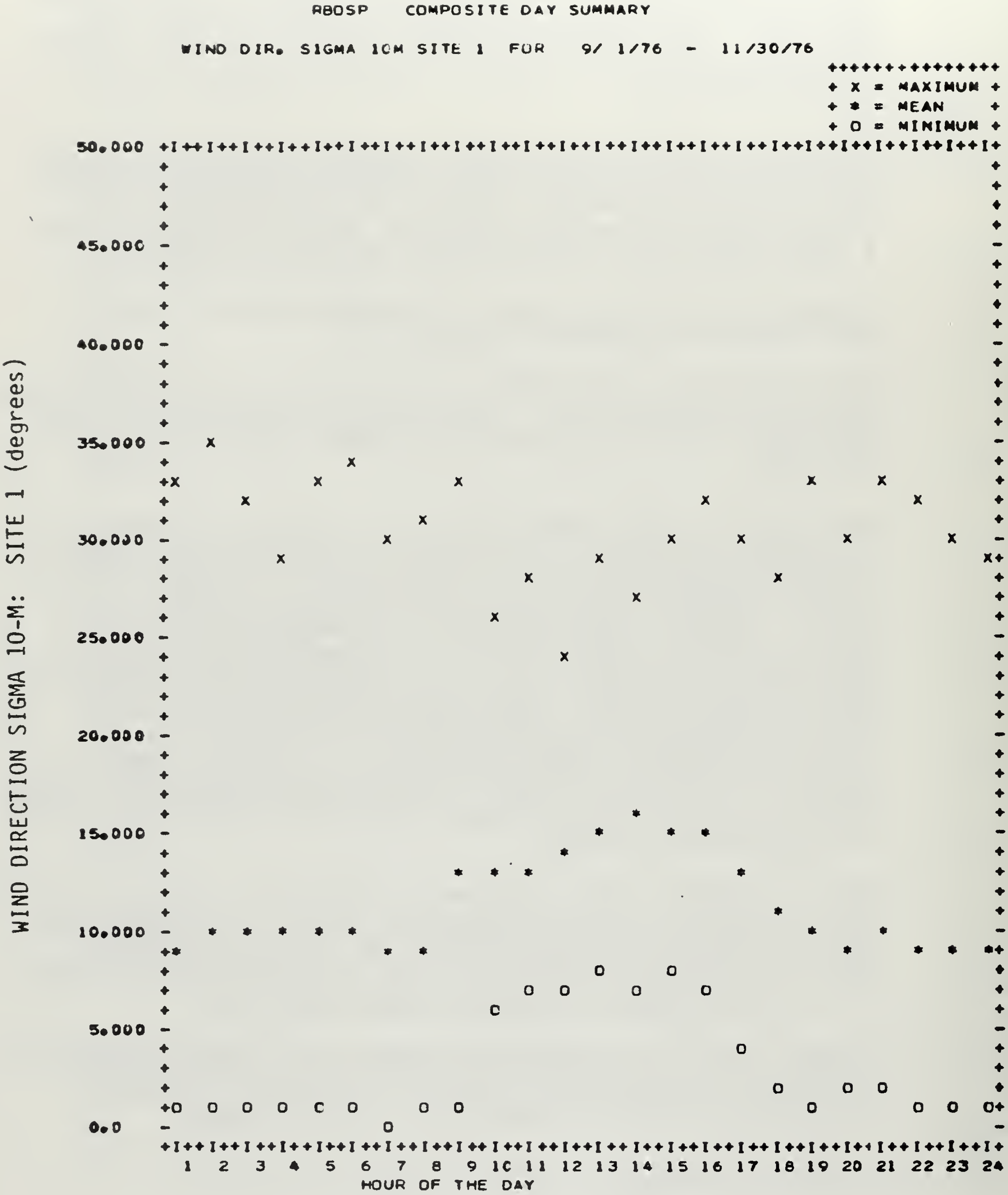


Figure 2.2-7. Wind direction sigma, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

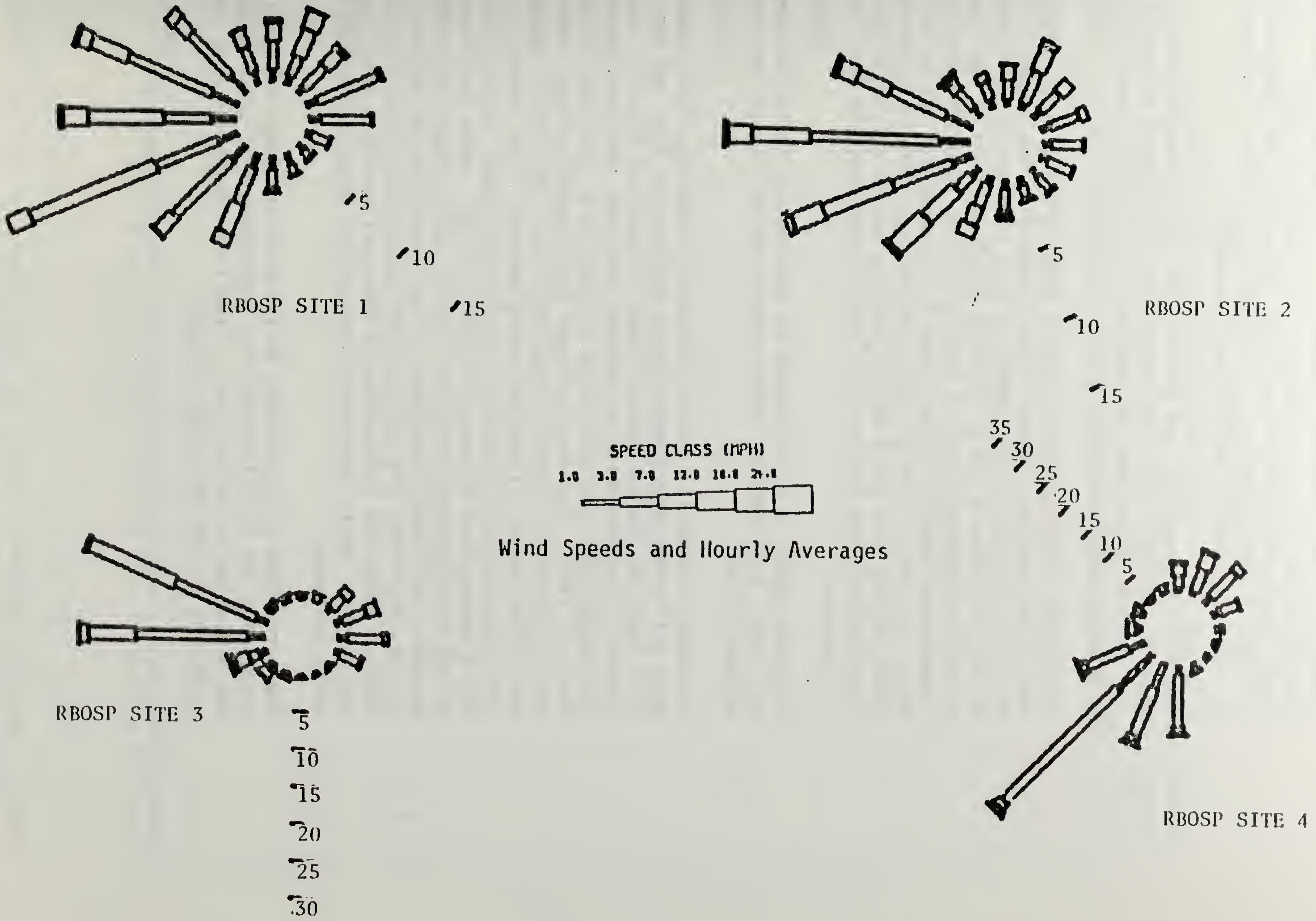


Figure 2.2-8. Wind roses for the 10-m level for Fall 1976 at Sites 1, 2, 3, and 4, RBOSP.

where Z_0 is the roughness parameter, K is the von Karman constant, and u* is the friction velocity. The seasonal data fit the logarithmic wind profile to a high degree of confidence (coefficient of determination, $r^2 = 0.926$) with u*/K = 0.30 mph, Z_o = 7.7 cm, and Z = height above ground.

The minimum, maximum, and mean values of air temperature for each of the four sites and temperature difference at Site 1 as a function of the hour of the day for Fall 1976, are plotted in Figures 2.2-9 through 2.2-14.

The valley sites (3 and 4) have a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Sites 1 and 2, is much greater. This is the result of valley drainage flows of cold air. The composite day air temperature data for Sites 3 and 4 indicate that colder air accumulates at Site 4. The elevation difference (200 feet) and the Stake Spring Draw air flow, as well as the Corral Gulch air flow draining into the Yellow Creek Gulch, contribute to this intensity difference.

Although there is a difference in the diurnal variation among all sites, the average temperatures over the season agree well between sites.

Atmospheric stability conditions were determined from temperature difference measurements made between the 10-m and the 60-m level on the main meteorological tower at Site 1. Figure 2.2-14 presents the minimum, maximum, and mean composite day temperature differences as a function of the time of day for Fall 1976. The data indicate that a mean surface inversion exists during the interval from 2000 hours MST in the evening until 0700 hours MST the following morning. The intensity of this mean surface inversion is relatively weak, ranging from delta temperature values of -0.04 to -0.69. When the break-up of the mean surface inversion occurs, delta temperature values become significantly unstable. The intensities of the most unstable conditions are greater than those of the most stable inversions. Since the intensities of the most unstable conditions are unusual, delta temperature values for these conditions are being reviewed.

The percentage of occurrence of the modified Pasquill stability categories for Fall 1976 and the associated mean wind speeds are presented in Table 2.2-2. Stability categories were calculated according to the following criteria.

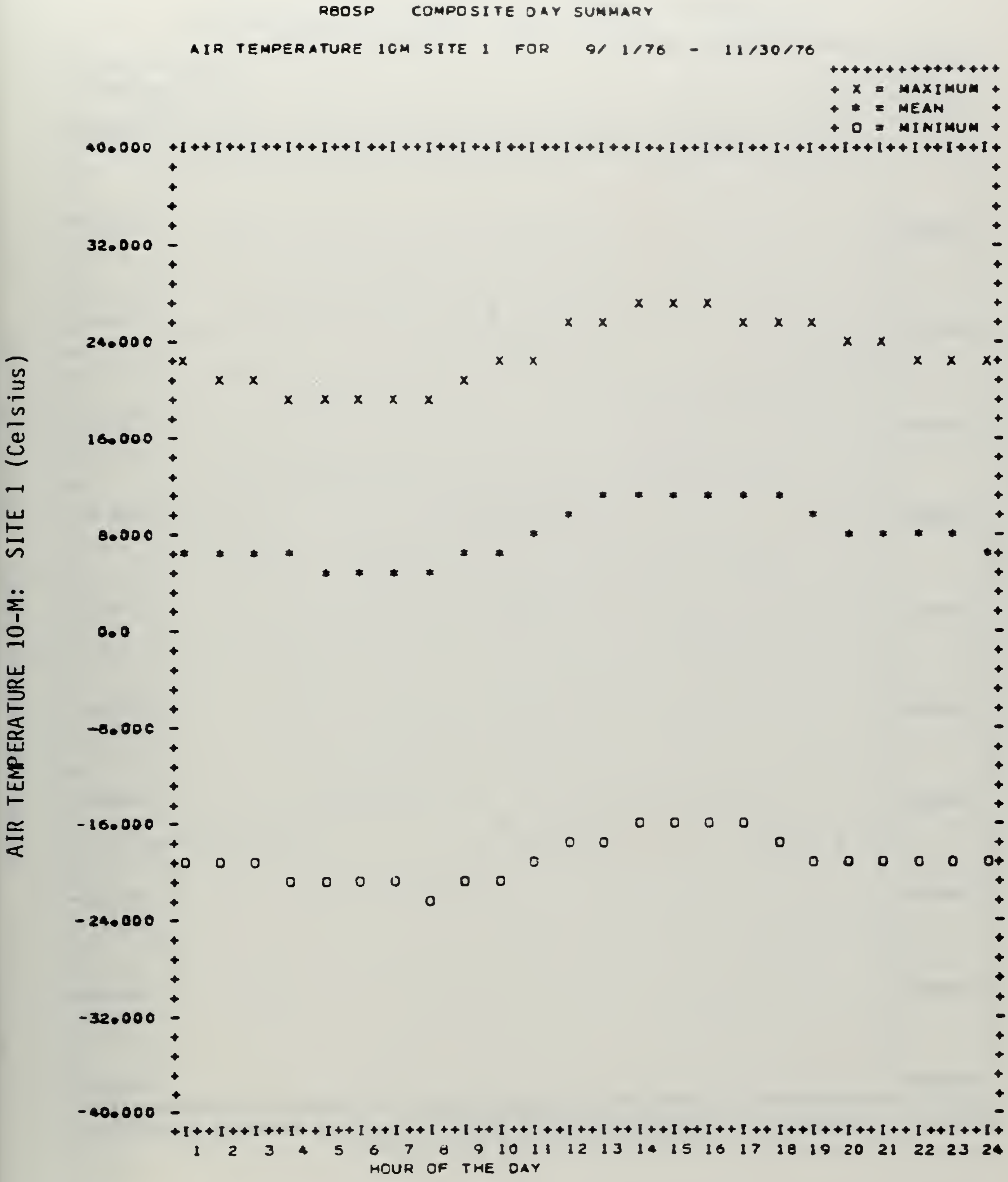


Figure 2.2-9. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

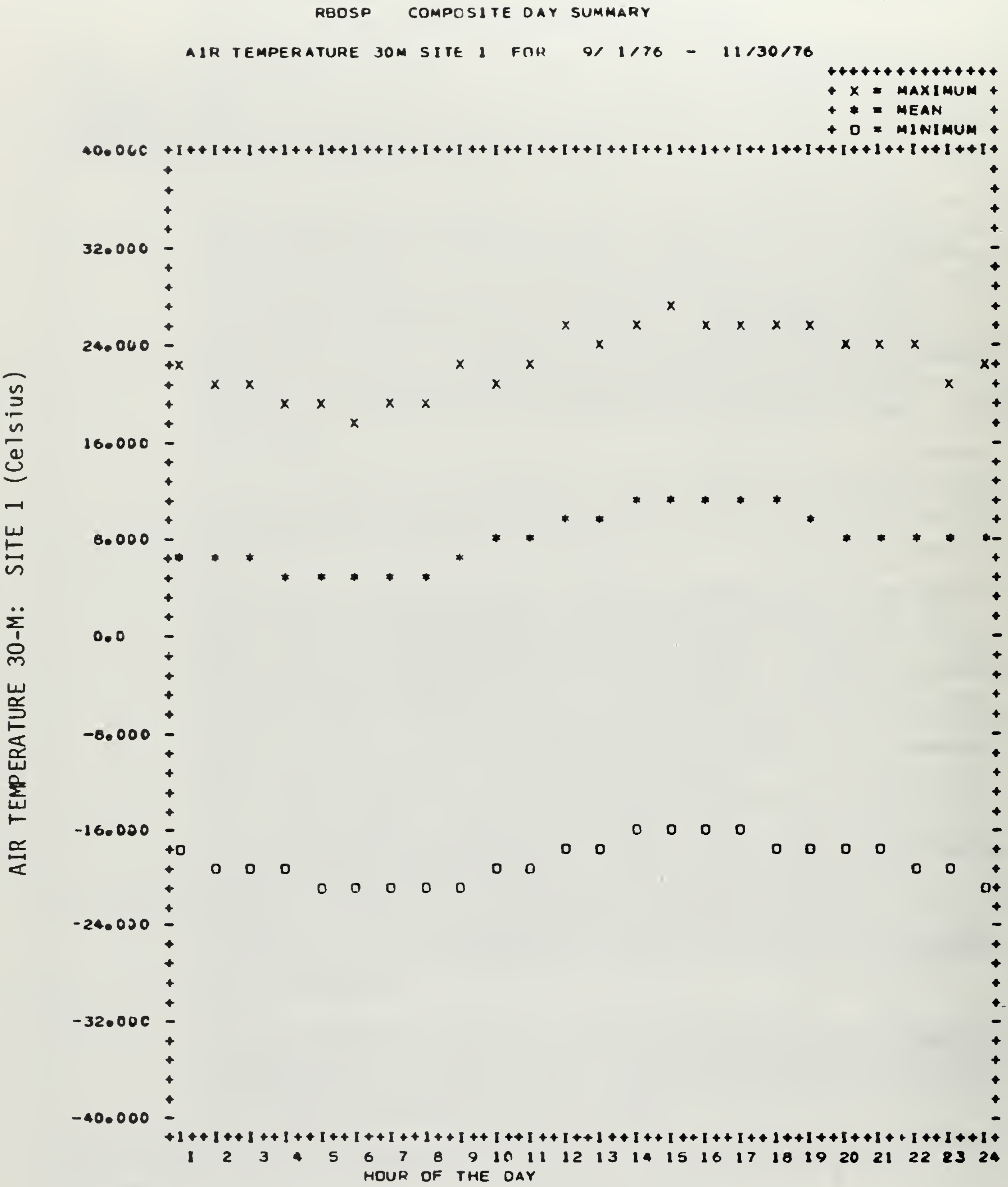


Figure 2.2-10. Air temperature, 30-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

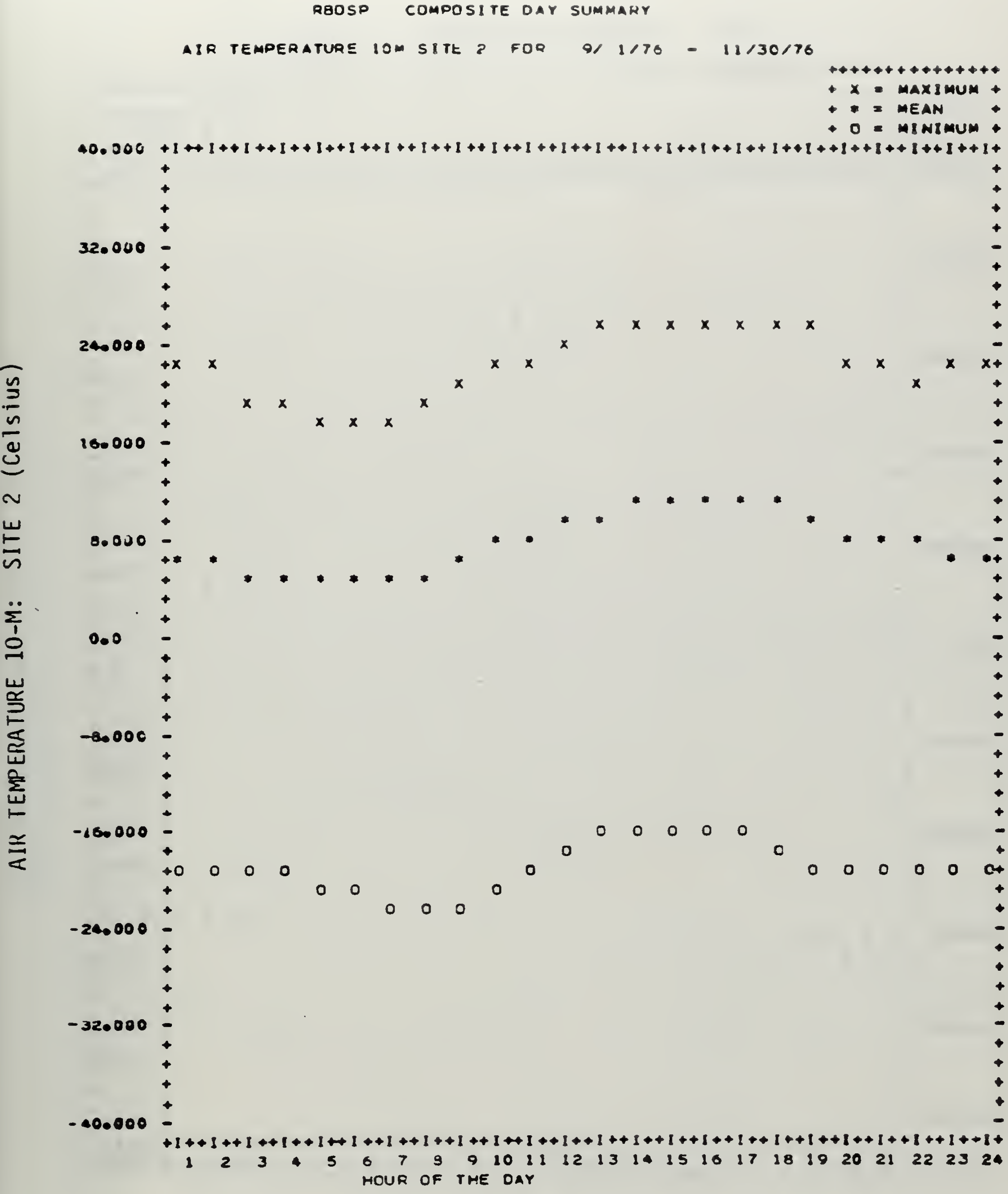


Figure 2.2-11. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 2, RBOSP.

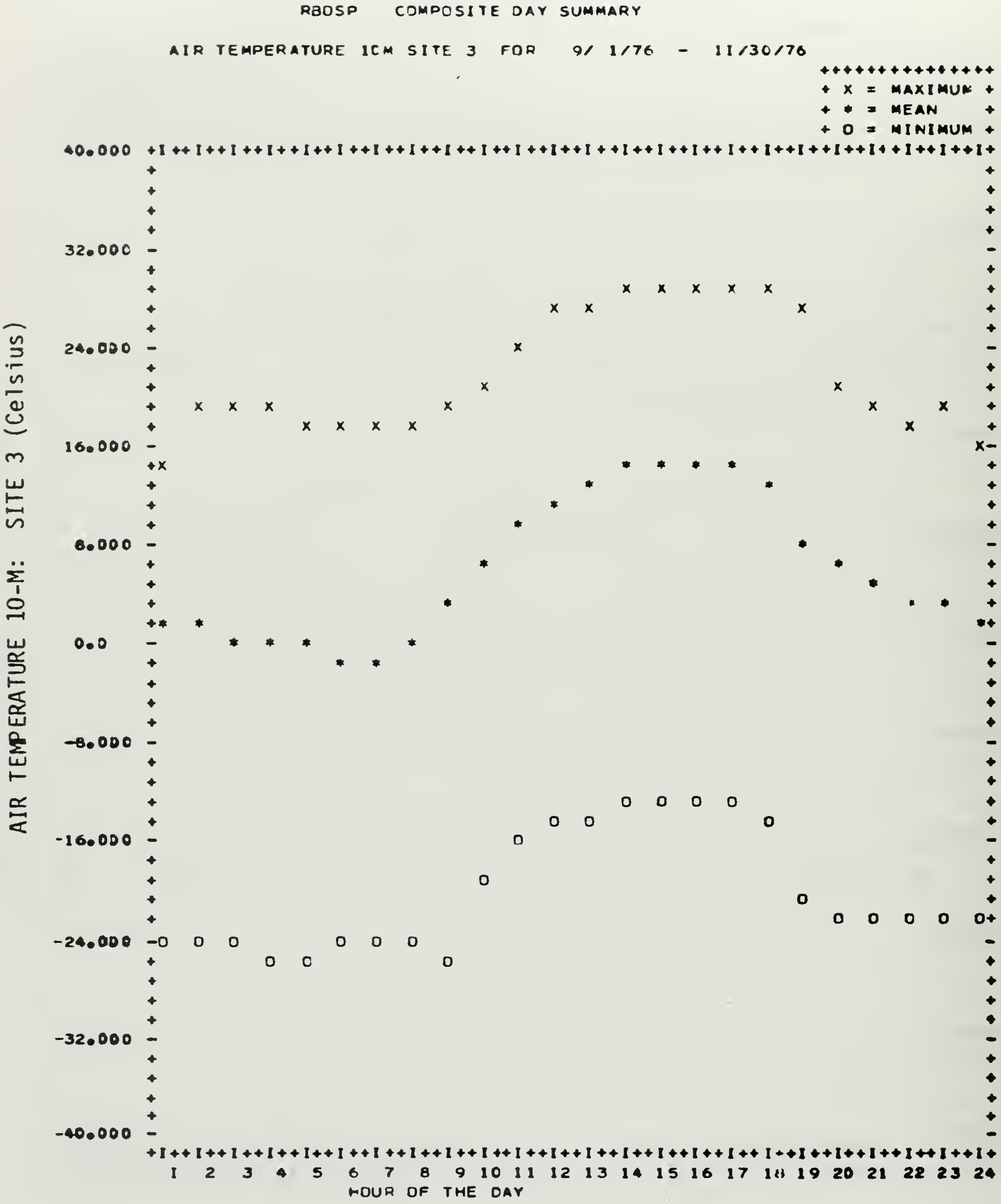


Figure 2.2-12. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 3, RBOSP.

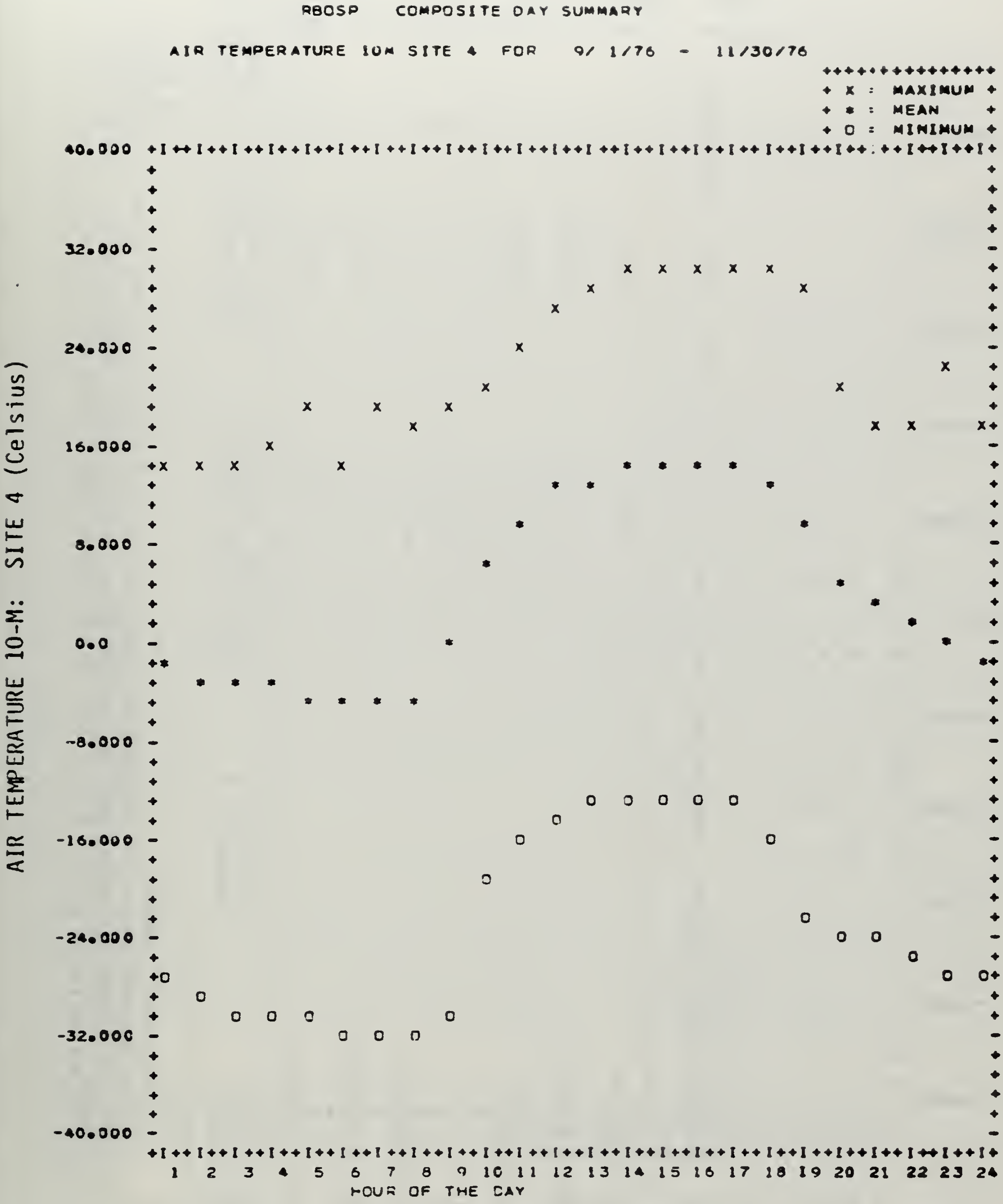


Figure 2.2-13. Air temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976, at Site 4, RBOSP.

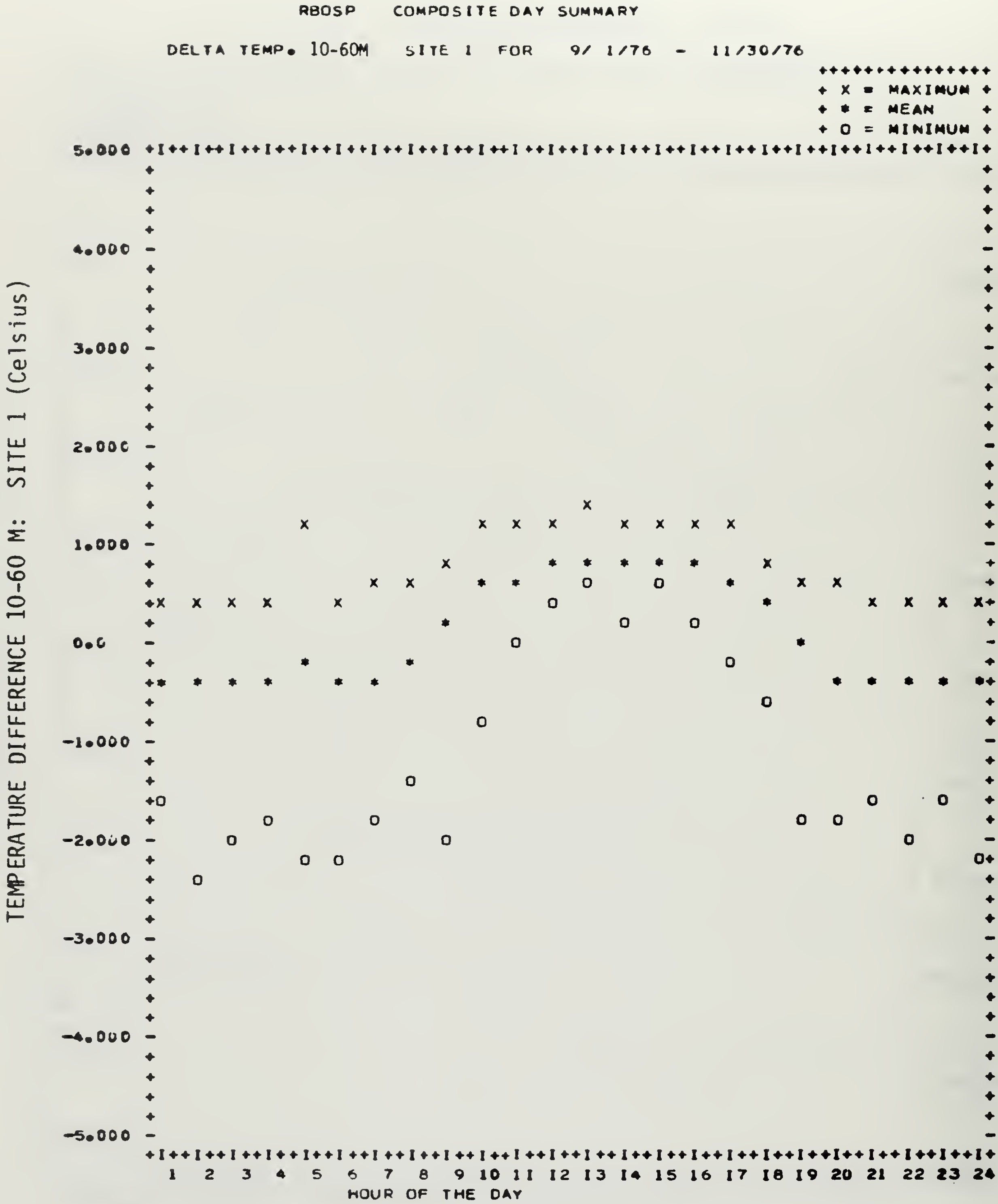


Figure 2.2-14. Temperature difference between 10-m and 60-m levels (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

Table 2.2-2. Percentage of occurrence of the Pasquill stability classes at Site 1. Stability category determined from the temperature difference between the 10- and 60-m levels during Fall 1976, RBOSP.

Stability Classification	Pasquill Categories	Temperature Change with Height (C/100 m)	Percentage of Occurrence	Mean Wind Speed (mph)
Extremely Unstable	A	Less than -1.9	4.25	10.74
Moderately Unstable	B	-1.9 to -1.7	4.40	9.76
Slightly Unstable	C	-1.7 to -1.5	6.52	8.95
Neutral	D	-1.5 to -0.5	27.73	7.19
Slightly Stable	E	-0.5 to 1.5	46.86	5.04
Moderately Stable	F	1.5 to 4.0	10.00	6.49
Extremely Stable	G	Greater than 4.0	0.24	6.59

Source: David H. Slade, Editor. Meteorology and Atomic Energy, Nat. Tech. Serv. TID-24190, pp. 102-103, 1971.

Stability Index	Temperature change (C) with heights per 100 m*
A	$\Delta T < -1.9$
B	$-1.9 \leq \Delta T < -1.7$
C	$-1.7 \leq \Delta T < -1.5$
D	$-1.5 \leq \Delta T < -0.5$
E	$-0.5 \leq \Delta T < 1.5$
F	$1.5 \leq \Delta T < 4.0$
G	$4.0 \leq \Delta T$

*ΔT is equal to minus two times delta temperature.

Figure 2.2-15 graphically presents the minimum, maximum, and mean composite day relative humidities as a function of hour of day for Fall 1976. The relative humidity data were taken at the 10-m level at Site 1. There was a significant decrease (6%) in the mean relative humidity at sunrise. The effect is probably due to the surface heating of the air. This composite daily transition period occurs over 2 hours. The decrease may also arise from the increased thermally generated turbulent mixing caused by the reversal of the mean lapse rate from slightly stable to slightly unstable and the increased surface temperature.

2.2.3 Miscellaneous

The meteorological parameters grouped into this category are precipitation, evaporation, solar radiation, noise, visibility, snow course, and tracer studies. All these parameters, except precipitation, tracer studies, and evaporation, are measured only at Site 1. Evaporation measurement is made at Site 3 because of water availability. The evaporation rate, snow course measurements, and visibility are not monitored continuously, but are recorded on a routine basis.

2.2.3.1 Precipitation Measurements

The precipitation data summary for the tipping bucket precipitation gage for Fall 1976 is presented in Table 2.2-3. The total and daily amounts of precipitation are shown for each site. Maximum total precipitation for 1 day was 0.25 inch at Site 3 on 8 August 1976. Site 3 registered the largest total precipitation (0.99 inches for Fall 1976).

Shielded weighing precipitation gages were installed at Sites 1 and 2 during the summer quarter. Data collection from these gages began on 30 June 1976. A summary of the shielded weighing precipitation gage data for Fall 1976 is presented in Table 2.2-4.

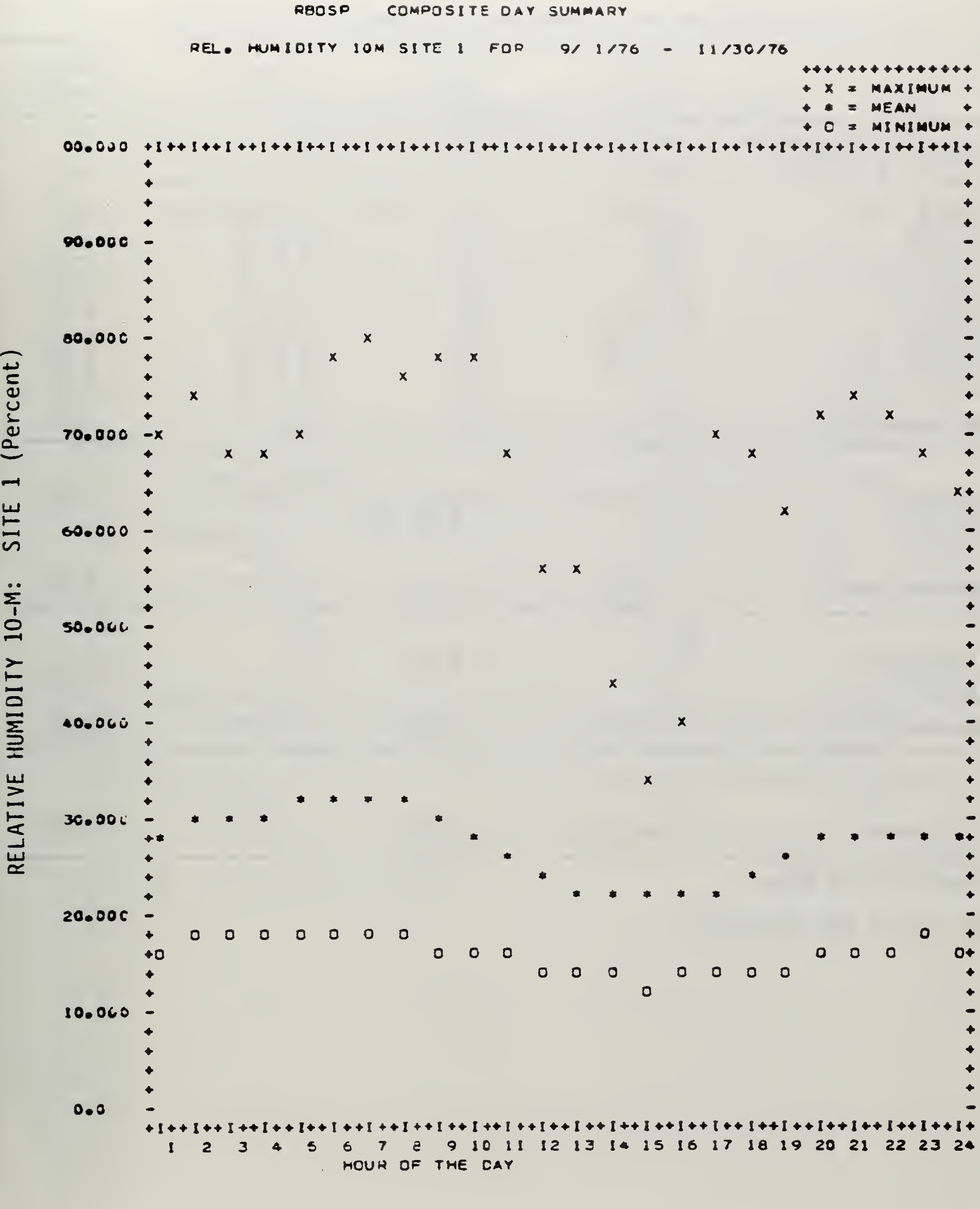


Figure 2.2-15. Relative humidity, 10-m level (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

Table 2.2-3. Precipitation data collected by tipping bucket gage for Fall 1976, RBOSP.

(Values are presented in inches of water)

Date	Site 1 Total	Site 2 Total	Site 3 Total	Site 4 Total
9/1/76 - 10/15/76	-	NA	-	-
9/11/76 - 9/22/76	NA	-	-	-
9/6/76	0.06	NA	0.10	0.12
9/11/76	NA	NA	0.01	-
9/12/76	NA	NA	0.01	-
9/14/76	NA	NA	0.09	0.08
9/22/76	0.13	NA	0.23	0.17
9/24/76	0.04	NA	0.21	0.13
9/25/76	0.06	NA	0.06	0.08
9/27/76	-	NA	0.02	0.01
September Total	0.29	NA	0.73	0.59
10/2/76	0.22	NA	0.25	0.24
10/25/76	-	0.01	-	-
10/26/76	-	-	0.01	
October Total	0.22	0.01	0.26	0.24
11/14/76	-	0.02	-	-
11/26/76	-	-	-	0.02
November Total	0.00	0.02	0.00	0.02
Fall Total	0.51*	0.03*	0.99	0.83

*Partial data only.

NA - Data not available.

Table 2.2-4. Precipitation data collected by weighing gage for Fall 1976, RBOSP

(Values are presented in inches of water)

Date		Site 1	Site 2
September	6 1976	0.09	0.09
	11	0.04	-
	12	-	0.03
	14	0.08	0.10
	21	0.06	-
	22	0.21	0.12
	23	-	0.01
	24	0.14	0.21
	25	0.11	0.08
	27	0.03	0.05
September Total		0.76	0.69
October	2 1976	0.24	NA
	3	-	NA
	23	NA	-
	24	NA	-
	25	0.05	-
	26	0.05	0.03
October Total		0.34	0.03
November Total		0.00	0.00
Fall Total		1.10	0.72

NA - Data not available.

Precipitation data for July and August 1976 have been reevaluated and the results show that measurements obtained from weighing gages are in agreement with measurements obtained from tipping bucket gages. In July and August 1976 there were 24 precipitation events identified in the measurement area during which the results from the two types of gages could be compared. The 24 precipitation events at Sites 1 and 2 resulted in 36 correlations of data. The accuracy of the weighing gage recording is estimated as ±1/2% of full scale or ±0.03 inch of precipitation; the tipping bucket recording accuracy is estimated at about ±0.01 inch. Collection efficiency of both gages is similar. In only four cases did the correlation fall outside these accuracy bounds.

Minimal precipitation and instrument problems combined reduced the number of comparable precipitation events during the Fall season. Of the seven comparable events, three correlation values were outside the accuracy specifications.

2.2.3.2 Evaporation Measurements

Data for Fall 1976 are presented in Table 2.2-5. Measurements were terminated for the 1976-1977 baseline data year with the measurement on 27 October 1976. The highest evaporation rate recorded was 0.025 $(g/cm^2)/hr$. This occurred during the week ending 4 September 1976. The minimum evaporation rate was 0.000 $(g/cm^2)/hr$ occurring during the measurement period ending 25 September 1976.

2.2.3.3 Solar Radiation Measurement

Solar radiation data were taken at 1.2 m above ground level at Site 1. The minimum, maximum, and mean composite day solar radiation measurements as a function of hour of the day for Fall 1976 are graphically presented in Figure 2.2-16. The seasonal and hourly minimum, maximum, and mean values of the solar radiation are presented in Table 2.2-6.

2.2.3.5 (a) Visibility Measurements (Tract C-a)

During Fall 1976, sector visibility ranged from <1 to >100 miles for each period that data were recorded. The <1 mile visibility occurred on 25 October 1976 (Tables 2.2-7 through 2.2-9).

2.2.3.5 (b) Visibility Measurements (Piceance Creek Basin)

Piceance Creek visibility measurements were made over a year-long period from September, 1975 through September, 1976. Results for each quarter through August, 1976 have been reported in previous reports. Results of the year-long study are summarized herein. For greater detail, see the Progress Report 9 - Interpretative Text.

Table 2.2-5. Evaporation data summary for Fall, 1976, RBOSP.

End Date of Measurement Period	Time of Measurement Hours (MST)	Precipitation Since Last Reading (in.)	Maximum Temperature Since Last Reading (C)	Minimum Temperature Since Last Reading (C)	Water Required To Fill Pan (in.)	Evaporation Rate ((g/cm^3)/hr)
9/4/76	1025	0	24	16	1.65	0.025
9/11/76	1320	0.10	24	6	1.30	0.018
9/18/76	0900	0	21	7	0.75	0.012
9/25/76	1505	0.45	20	5	0.45	0.000
10/2/76	1223	0.20	15	2	0.90	0.011
10/9/76	1400	0.25	24	1	0.30	0.001
10/16/76	1132	0	15	2	0.90	0.013
10/23/76	1305	0	25	-1	0.72	0.011
10/27/76*	1100	0.01	12	-0.5	0.36	0.009

*Last sample of the season.

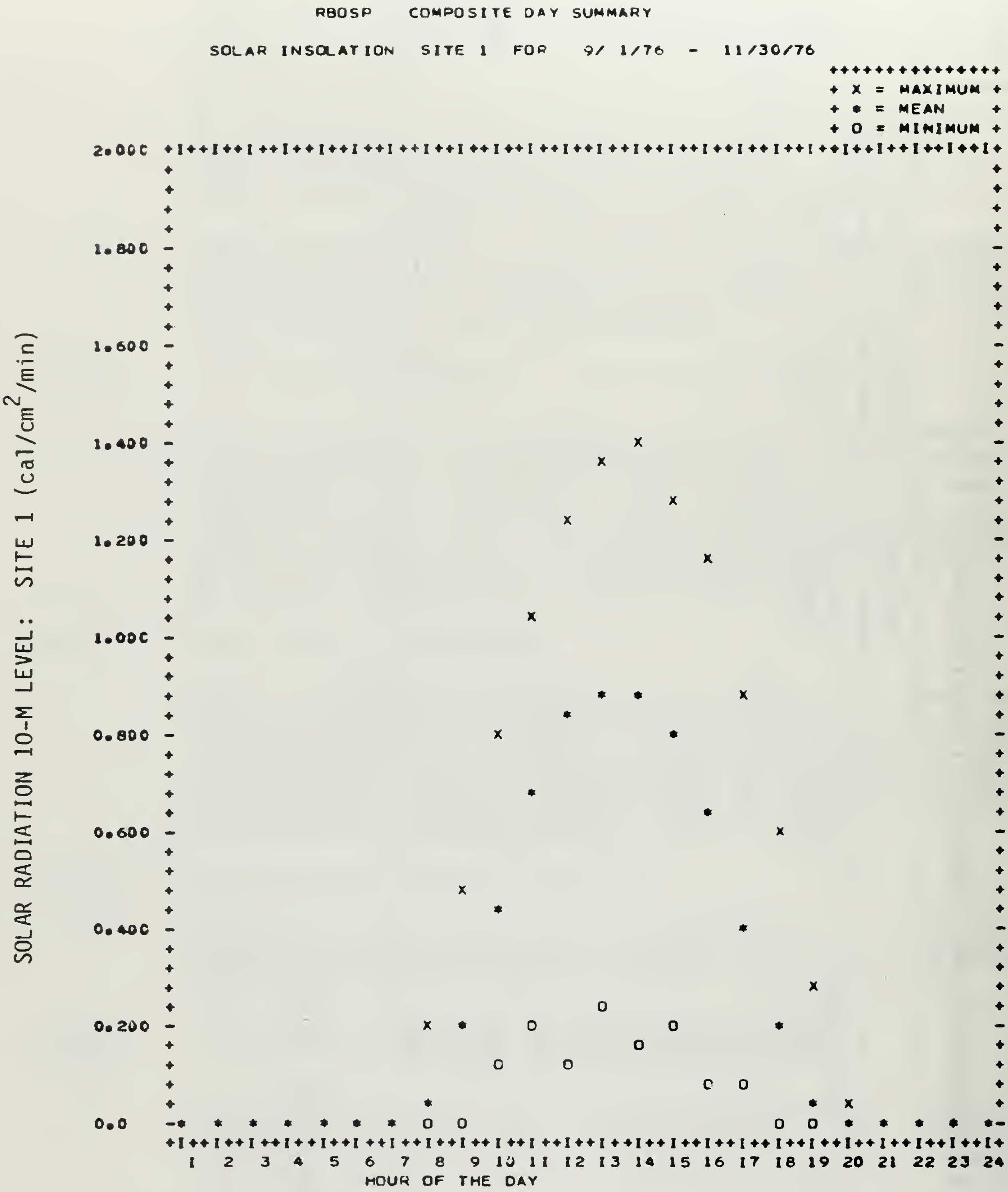


Figure 2.2-16. Solar radiation (minimum, maximum, and mean by hour of the day) for Fall 1976 at Site 1, RBOSP.

Table 2.2-6. Solar radiation, seasonal and monthly summary for Fall 1976; values are in Langleys or cal/cm^2/min, RBOSP.

	September	October	November	Fall 1976
Minimum	0.00	0.00	0.00	0.00
Maximum	1.38	1.17	0.89	1.38
Mean	0.32	0.26	0.19	0.26

Table 2.2-7. Visibility data for September 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility (miles)				Prevailing Visibility (miles)	Estimated Cloud Coverage(%)
			N	E	S	W		
9/1/76	1150	0	80	80	80	80	80	0
9/4/76	0937	0	80	80	80	80	80	0
9/6/76	1255	0	80	80	80	80	80	100
9/10/76	1010	0	80	80	80	80	80	100
9/16/76	1100	0	80	80	80	80	80	40
9/19/76	1400	0	80	80	80	80	80	15
9/22/76	1410	0	80	80	80	80	80	60
9/25/76	1420	0.03	60	60	80	80	80	100
9/28/76	1510	0.07	80	80	80	80	80	5

Table 2.2-8. Visibility data for October 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility (miles)				Prevailing Visibility (miles)	Estimated Cloud Coverage(%)
			N	E	S	W		
10/1/76	1505	0	80	80	80	80	80	75
10/4/76	1325	0	80	80	80	80	80	15
10/7/76	1152	0	80	80	80	80	80	5
10/10/76	1145	0	80	80	80	80	80	5
10/13/76	1052	0	>80	>80	>80	>80	>80	0
10/16/76	1255	0	100	100	100	100	100	1
10/19/76	1206	0	80	80	80	80	80	5
10/22/76	1410	0	80	80	80	80	80	80
10/25/76	1530	0	<1	<1	<1	<1	<1	100
10/28/76	1443	0	80	80	80	80	80	0
10/31/76	1610	0	100	100	100	100	100	0

Table 2.2-9. Visibility data for November 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility (miles)				Prevailing Visibility (miles)	Estimated Cloud Coverage(%)
			N	E	S	W		
11/3/76	1530	0	80	80	80	80	80	35
11/6/76	1225	0	>100	>100	>100	>100	>100	10
11/8/76	1220	0	150	150	150	150	150	75
11/12/76	1440	0	80	80	80	80	80	80
11/15/76	1055	0	60	60	60	60	60	25
11/18/76	1445	0	80	80	80	80	80	15
11/21/76	1600	0	80	80	80	80	80	0
11/24/76	1350	0	>100	>100	>100	>100	>100	1
11/27/76	1400	0	80	80	80	80	80	10
11/30/76	1340	0	100	100	100	100	100	90

Daily mean visual ranges during the year-long study were generally high; 95% of the daily means were greater than 42 miles, 50% exceeded 78 miles. Daily means in excess of 100 miles were common. The maximum daily mean visual range recorded was 130 miles during November, 1975. The minimum daily mean visual range of 32 miles was recorded in December, 1975. Daily mean visual ranges and hourly maxima and minima for the year (September, 1975 - September, 1976) are summarized in Table 2.2-10. Fluctuations in these mean daily visual ranges for the year are illustrated in Figure 2.2-17.

Monthly mean visual range values varied from 67 to 99 miles.(Table 2.2-11). Values obtained during 1975 fluctuated widely, but values obtained during 1976 were more uniform. Maxima monthly hourly visual ranges varied from 113 to 149 miles (Table 2.2-11). Minima monthly hourly values ranged from 14 to 45 miles. Individual minimum visual ranges did not reflect trends exhibited by maximum values.

Mean seasonal visual ranges were highest during the fall of 1975, lowest during the Spring of 1976 and nearly equal during Winter 1975-76 and Summer 1976. Seasonal visual range data are presented in Table 2.2-12. Directional variations were detected in every season.

2.2.3.6 Tracer Studies

The field data collection portion of the tracer studies was completed during this quarter. The field portion was reviewed while in progress by the EPA, AOSO, RBOSP, and CDM/Limnetics. This assistance rendered by the personnel of these organizations contributed to a successful data collection effort.

2.2.3.7 Snow Course Measurements

No snow course measurements were taken during Fall 1976.

Table 2.2-10. Daily mean visual ranges, Piceance Creek Basin, Colorado. September 1975 - September 1976, RBOSP.

DATE	MEAN VISUAL RANGE (miles)	HOURLY MIN/MAX	DATE	MEAN VISUAL RANGE (miles)	HOURLY MIN/MAX
September 25, 1975*	103	79/131	April 1	101	66/138
26*	87	69/119	7	45	18/72
27	59	42/77	13	48	16/58
October 3	93	68/114	19	56	14/109
9	116	84/144	25	72	45/106
15	66	44/93	May 1	75	57/124
21	99	78/117	7	56	30/82
27	63	42/98	13	76	57/101
November 2	106	82/130	19	58	27/75
8	66	24/92	25	65	33/89
14	130	106/140	31	88	61/112
20	80	44/144	June 6	59	45/74
26	95	44/128	12	84	61/101
December 2	98	69/145	18	68	50/113
8	88	45/139	24	81	64/117
14**	32	17/60	30	62	46/84
20	109	81/147	July 6	71	57/99
27	53	28/88	12	61	45/80
January 2, 1976	44	27/64	18	62	45/96
8	66	28/104	24	92	74/120
14	102	47/64	30	68	55/95
20	91	46/134	August 5	96	72/125
26	57	39/72	11	98	72/138
February 1	105	46/149	17	94	60/128
7	46	25/65	23	69	45/94
13	85	59/125	29	109	91/138
19	102	64/143	September 4	84	70/111
25	79	46/118	10	86	61/113
March 2	37**	27/55	16	64	46/84
8	61	45/89	22	54	35/88
14	65	38/93			
20	85	57/116			
26	75	46/102			

*Half-day practice sessions
**Based on two hours of data

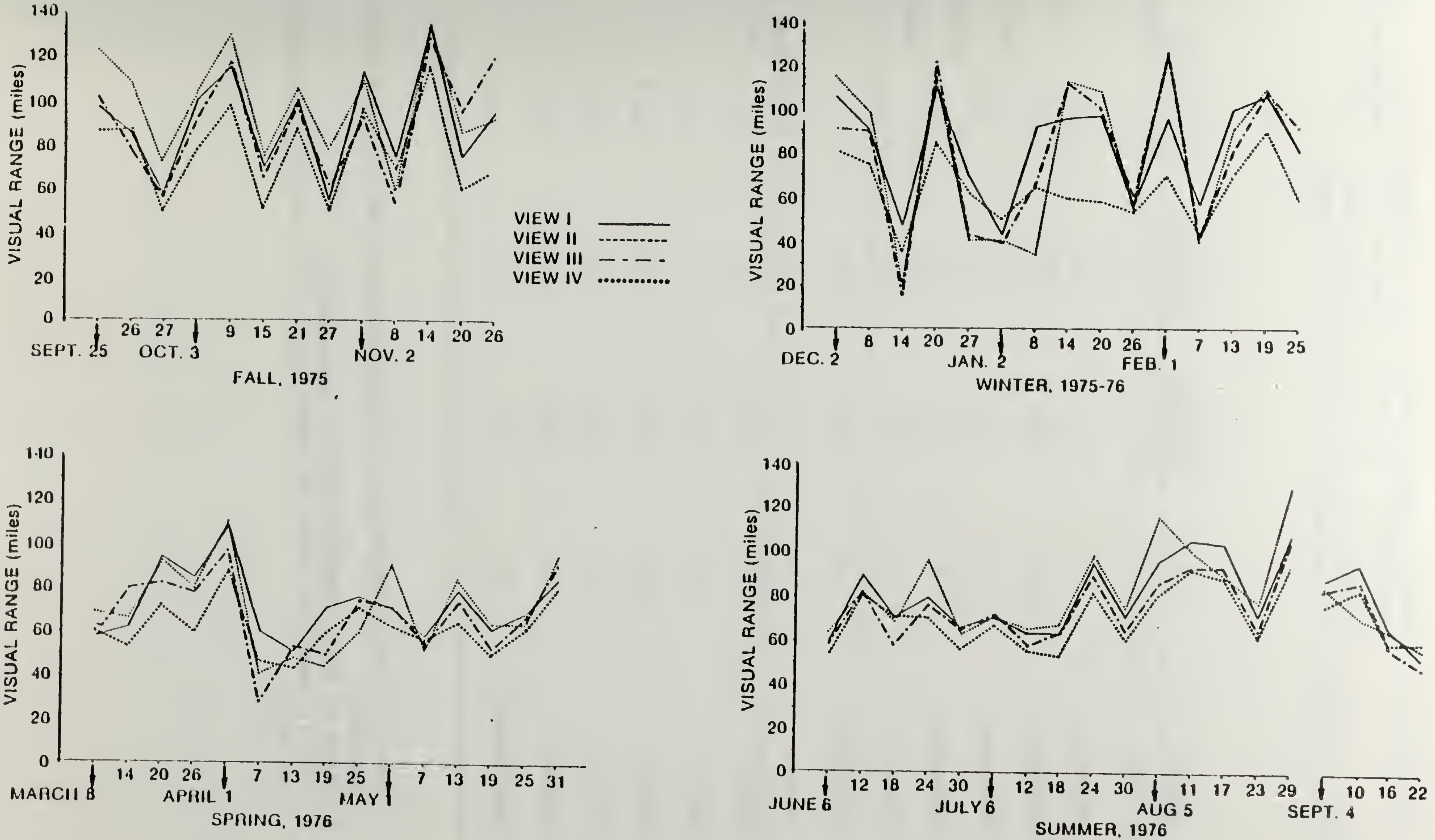


Figure 2.2-17. Variation in daily mean visual range for each view. Piceance Creek Basin, Colorado. September 1975 - September 1976, RBOSP.

Table 2.2-11. Monthly composite visual range summary (miles). Piceance Creek Basin, Colorado. September 1975 - September 1976, RBOSP.

MONTH	MEAN[c]	HOURLY MAXIMUM	HOURLY MINIMUM	STANDARD DEVIATION
September 75[a]	77	131	42	24.0
October	89	144	44	24.6
November	99	149	24	29.0
December	86	147	17	31.1
January 76	72	137	27	29.2
February	84	149	25	28.2
March	70	116	27	19.2
April	67	138	14	27.7
May	70	124	27	16.7
June	71	117	45	14.8
July	72	120	45	15.9
August	94	147	45	20.1
September[b]	74	113	35	17.9

a Based on one scheduled day of photography and two half-day practice sessions.
b Based on four scheduled days of photography
c Monthly means are based on approximately five days of photography per month.

Table 2.2-12. Seasonal composite visual range summary (miles). Piceance Creek Basin, Colorado. September 1975 - September 1976, RBOSP.

SEASON	MEAN	HOURLY MAXIMUM	HOURLY MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
Fall	91	149	24	45	27.3
Winter	80	149	17	33	30.0
Spring	69	138	14	39	21.1
Summer	79	147	45	51	20.0

* 5 percent of the observations gave a visual range less than the indicated value

2.3 TERRESTRIAL STUDIES

2.3.1 Vegetation

Ten different vegetation types were sampled on or near Tract C-a during September 1976 (fall quarter). The herbaceous stratum was sampled in all 10 vegetation types along 35 permanent transects during September 1976 while 27 non-permanent transects were surveyed for shrub-seedling and mature tree stratum data in the ten vegetation types during the same period.

Important parameters describing the structural and compositional nature of each stratum within each vegetation type are presented and discussed.

Table 3-7-3 of the Second Annual Report (RBOSP, 1976) provides a comprehensive list of vegetative species encountered on the Tract C-a study area. New plant species encountered on the study area subsequent to the publication of the Second Annual Report are listed in Quarterly Reports. Table 2.3-1 of this quarterly report lists the new plant species encountered on the Tract C-a study area this quarter.

Aspen - during the fall quarter the aspen type was sampled by two permanent and one non-permanent transects. Shrub-tree seedling and mature tree strata were measured only on the non-permanent transect while the herbaceous stratum only was measured along the permanent transects. Three strata and 25 different species were identified for the aspen type during September 1976 sampling: 2 species in the mature tree stratum; 6 species in the shrub-tree seedling stratum; and 17 species in the herbaceous stratum. Populus tremuloides and Pseudotsuga menziesii occurred in both the shrub-tree seedling and mature tree strata.

The aspen vegetation type was sampled over an elevational range of 2481 to 2652 m (8140 to 8700 ft) where it occurs primarily on deep, loamy soils which are high in organic matter.

The mature tree stratum consisted of two species, Populus tremuloides and Pseudotsuga menziesii, and contributed a total cover of 51%. Populus tremuloides dominated the mature tree stratum and provided a relative cover of 95%, a density of 867 individuals per hectare and a basal area of 8.22 m^2 per hectare.

Six shrub-tree seedling species contributed a total cover of 87% and a total density of 12,317 individuals per hectare during September 1976 sampling of the aspen shrub-tree seedling stratum. Symphoricarpos oreophilus and Amelanchier utahensis were the dominant species contributing 76% of the total cover.

Table 2.3-1. Additions to the list of plant species observed during September, 1976 in the vicinity of Tract C-a for RBOSP (see Section 7.1A, Table 3-7-3 of the Second Annual Report, 1976)

Abbreviation [1]	Species
	SHRUBS
Atnu	*Atriplex nuttallii* S. Wats; [2] (Chenopodiaceae), [3] Cham, [4] Nuttall saltbush, (N) [5] (V) [6]
Rhtr	*Rhus trilobata* NuH.; (Anacardiaceae) Phan, skunkbush sumac, (N)(V)
	HERBACEOUS (NON-GRASSLIKE)
Atar	*Atriplex hortensis* L.; (Chenopodiaceae), Ther, Orache, (I)(V)
Bahy	*Bassia hyssopifolia* (Pall.) Kuntze; (Chenopodiaceae), Ther, five hook bassia, (I)(V)
Seam	*Senecio ambrosioides* Rydb.; (Compositae), Ther, groundsel, (N)(V)
Sede	*Senecio debilis* Nutt.; (Compositae), Hemi, groundsel, (N)(V)
	HERBACEOUS (GRASS-LIKE)
Agal	*Agrostis alba* L.; (Graminae), Cham, redtop, (I)(V)
Muas	*Muhlenbergia asperifolia* (Nees et May), Parodi; (Gramineae), alkali muhly, (N)(V)

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[1] Abbreviation of genus and species in a four-letter code.

[2] Author citation, nomenclatural authority cited after each species name and delineated by a semicolon.

[3] The family of plants to which a species belongs in parentheses.

[4] Lifeforms of Plants

Phan (Phanerophyte) - Perennating bud at least 0.25 m above soil surface.

Cham (Chamaephyte) - Perennating bud between 0 and 0.25 m above soil surface.

Table 2.3-1 (Continued)

Footnotes (Continued)

[4] Lifeforms of Plants (Continued)

Hemi (Hemicryptophyte) - Perennating bud in soil surface.
Cryp (Cryptophyte) - Perennating buds covered by soil or water.
Ther (Therophyte) - Annual plants, perennating buds contained in seed.
Succ (Succulent) - Stems enlarged; serve as water storage organ.

[5] Origin of plant species

(N) - Native to the North American continent.
(I) - Introduced from outside the North American continent.

[6] (V) - Voucher specimen collected.

The herbaceous stratum was composed of 17 different species contributing a total cover of 21%. Carex geyeri and Bromus marginatus were the dominant herbaceous species contributing nearly 15% of the total herbaceous cover.

Douglas fir - The Douglas-fir type was sampled during September, 1976 by 2 permanent and one non-permanent transects. Shrub-tree seedling and mature tree strata were measured along the non-permanent transects while the herbaceous stratum only was measured along the two permanent transects. Three strata and 24 different species were identified for the Douglas-fir type during July 1976 sampling: one species in the mature tree stratum; 8 species in the shrub-tree seedling stratum; and 15 species in the herbaceous stratum. Pseudotsuga menziesii was encountered in both the shrub-tree seedling and mature tree strata.

The Douglas-fir vegetation type was sampled over an elevational range of 2378 to 2591 m (7800 to 8500 ft) where it occurs on steep slopes with shallow soils.

The mature tree stratum contained only one species, Pseudotsuga menziesii which contributed a total cover of 10%, occurred at a density of 150 individuals per hectare and a basal area of 2.8 m^2 per hectare.

Eight shrub-tree seedling species contributed a total cover of 92% and a total density of 9,192 individuals per hectare in the Douglas-fir shrub-tree seedling stratum sampled during the fall quarter. Symphoricarpos oreophilus and Amelanchier utahensis were the dominant shrub species contributing 67% of the total cover in the shrub-tree seedling stratum.

The pinyon-juniper vegetation type was sampled over an elevational range of 1987 to 2262 m (6520 to 7420 ft) where it occurs primarily on shallow, well-drained soils derived from sandstone.

The mature tree stratum was comprised of 2 species, Pinus edulis and Juniperus osteosperma which contributed a total cover of 18% and a total density of 223 individuals per hectare. Juniperus osteosperma occurred at a greater density and frequency than Pinus edulis.

Fifteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 7%. Artemisia tridentata was the dominant shrub species contributing over 4% of the total shrub cover.

The herbaceous stratum was comprised of 25 species which contributed a total cover of only 5%. Two grasses, Agropyron trachycaulum and Poa sandbergii were the dominant herbaceous species providing a relative cover of over 54%.

Sagebrush - During the fall quarter, the sagebrush vegetation type was sampled with seven permanent and eight non-permanent transects. The shrub-tree seedling stratum was measured only on the non-permanent transects while herbaceous vegetation was surveyed only along the permanent transects. Two strata and 56 different species were identified for the sagebrush type during September, 1976 sampling: 16 species in the shrub-tree seedling stratum, and 40 species in the herbaceous stratum.

The sagebrush vegetation type was sampled over an elevational range of 1957 to 2600 m (6420 to 8530 ft) where it occurs on well-drained soils ranging from shallow to deep depending on the topography of the area sampled and on the origin (alluvial or sandstone-derived) of the soil.

Sixteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of over 25%. Artemisia tridentata was the dominant shrub species contributing almost 20% of the total shrub cover.

The herbaceous stratum was comprised of 40 species which contributed a total cover of 12%. A grass, Poa sandbergii, and a sedge, Carex geyeri, were the dominant herbaceous species together providing a relative cover of over 39%.

Greasewood - During the fall quarter, the greasewood vegetation type was sampled on three permanent transects. Greasewood was not sampled with non-permanent transects during September since all available greasewood stands have already been sampled. As discussed in the Second Annual Report (RBOSP 1976, page 3-7-41), greasewood is considered an association within the sagebrush type.

The greasewood vegetation association was sampled over an elevational range of 1905 to 2134 m (6250 to 7000 ft) where it occurs on deep, well-drained alluvial soils.

The herbaceous stratum on the three permanent transects was comprised of 6 species which contributed a total cover of 11%. The dominant herbaceous species were Chenopodium sp. and Kochia iranica, together providing a relative cover of over 68%.

Rabbitbrush - During the fall quarter, rabbitbrush was sampled on two permanent transects. No non-permanent transects were sampled in rabbitbrush in September 1976. As discussed in the Second Annual Report (RBOSP 1976, page 3.7-43), rabbitbrush is considered a seral stage in the bottomland sagebrush association. Few stands of rabbitbrush in the study area remain unsampled.

The rabbitbrush vegetation association was sampled over an elevational range of 2012 to 2073 m (6600 to 6800 ft) where it occurs on deep, well-drained alluvial soils.

The herbaceous stratum along the 2 permanent transects was comprised of 8 species which contributed a total cover of 26%. Elymus cinereus was the dominant herbaceous species providing a relative cover of 89%.

Bald (Upland Meadow) - During the fall quarter, the bald vegetation type was sampled with two permanent and three non-permanent transects. The shrub-tree seedling stratum was measured only on the non-permanent transects. Two strata and 30 different species were identified for the bald type during September 1976 sampling: 7 species in the shrub-tree seedling stratum and 23 species in the herbaceous stratum.

The bald vegetation type was sampled over an elevational range of 2256 to 2600 m (7740 to 8530 ft) where it occurs on shallow, well-drained soils derived from sandstone.

Seven shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 3%. Tetradymia canescens was the dominant shrub species contributing over 2% of the total shrub cover.

The herbaceous stratum was comprised of 23 species which contributed a total cover of 17%. Poa sandbergii, Haplopappus acaulis, and Agropyron trachycaulum were the dominant herbaceous species providing a total cover of almost 7%.

Shadscale - During the fall quarter, the shadscale vegetation type was sampled with two permanent transects. Because of its limited distribution in the area, no non-permanent shadscale transects were sampled in September 1976.

The shadscale vegetation type was sampled over an elevational range of 2027 to 2076 m (6650 to 6810 ft) where it occurred on shallow soils derived from sandstone and platy siltstone outcrops.

The herbaceous stratum was comprised of 7 species which contributed a total cover of almost 4%. Artemisia frigida and Eriogonum lonchophyllum were the dominant herbaceous species, together providing a relative cover of 80%.

Riparian - During the fall quarter, the riparian vegetation type was sampled with three permanent and two non-permanent transects. The shrub-tree seedling stratum, when present, was measured only on the non-permanent transects while herbaceous vegetation was surveyed only along the permanent transects. Two strata and 26 different species were identified for the riparian type during September 1976 sampling: 20 species in the herbaceous stratum and 6 species in the shrub-tree seedling stratum.

The riparian vegetation type was sampled over an elevational range of 1935 to 2195 m (6350 to 7200 ft) where it occurred on deep, well-drained alluvial soils.

Six shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 7%. Artemisia tridentata was the dominant shrub species contributing nearly 6% of the total shrub cover.

The herbaceous stratum was comprised of 20 species which contributed a total cover of 83%. Agropyron repens and Elymus cinereus were the dominant herbaceous species providing a relative cover of over 76%.

Literature cited

RBOSP. 1976. Second Annual Report for the Terrestrial Data Accumulation Program. Rio Blanco Oil Shale Project. January 1976. 3 volumes.

2.3.3 Small Mammals

Small mammal live trapping operations were conducted on fourteen grids in fourteen different vegetation types and variants of major vegetation types during September, 1976. All grids were sampled for five consecutive nights. Nine hundred and sixty-four individuals comprising eleven different species were captured during September, 1976 sampling. The different species captured along with their estimated overall relative abundance based on the number of individuals captured per 100 trap nights are shown in Table 2.3-2.

The least chipmunk (Eutamias minimus) was the most frequently captured small mammal during September 1976 and accounted for over 46% of the total relative abundance (Table 2.3-2). It was captured at all fourteen live trapping grids but was most abundant at mixed brush, pinyon-juniper/mixed brush and rabbitbrush grids.

The deer mouse (Peromyscus maniculatus) was the second most frequently captured small mammal species during September 1976 and accounted for over 36% of the total relative abundance (Table 2.3-2). The deer mouse was captured at all fourteen sampling grids but was most abundant at rabbitbrush and pinyon-juniper/sagebrush grids.

The Colorado chipmunk (Eutamias quadrivitattus) accounted for slightly over 9% of the total small mammal relative abundance during September 1976 (Table 2.3-2) and was captured at nine of the fourteen small mammal sampling sites. The Colorado chipmunk was most abundant at the four pinyon-juniper sites but was also regularly captured at the Douglas-fir grid.

The red-backed vole (Clethrionomys gapperi) accounted for almost 3% of the total small mammal relative abundance during September 1976 (Table 2.3-2) but was captured only at the higher elevation aspen

Table 2.3-2. Summary of trapping results for all small mammal species captured at all grids during sample period 9, September 1976, for RBOSP.

Species	# Individuals Captured	Individuals Captured Per 100 Trap Nights 1/	Relative Abundance 2/
Spermophilus tridecemlineatus (thirteen-lined ground squirrel)	5	0.09	0.51
Spermophilus lateralis (golden-mantled ground squirrel)	8	0.16	0.83
Eutamias minimus (least chipmunk)	448	8.81	46.48
Eutamias quadrivittatus (Colorado chipmunk	89	1.74	9.24
Lagurus curtatus (sagebrush vole)	2	0.02	0.21
Peromyscus maniculatus (deer mouse)	348	6.84	36.10
Peromyscus truei (pinon mouse)	22	0.44	2.28
Neotoma cinerea (bushy-tailed woodrat)	4	0.07	0.41
Microtus longicaudus (long-tailed vole)	4	0.07	0.41
Microtus montanus (Montane vole)	6	0.11	0.62

and Douglas-fir grids where it accounted for over 51% of the total relative abundance at the aspen grid and over 48% of the total relative abundance at the Douglas-fir grid.

The piñon mouse (*Peromyscus truei*) accounted for slightly over 2% of the total small mammal relative abundance during September 1976 (Table 2.3-2) and was captured only at grids placed in pinyon-juniper vegetation types (pinyon-juniper/sagebrush, pinyon-juniper/north slope, and pinyon-juniper/south slope). The piñon mouse was most abundant (over 46% relative abundance) at the pinyon-juniper/south slope sampling site.

The thirteen lined ground squirrel (*Spermophilus tridecemlineatus*), sagebrush vole (*Lagurus curtatus*), bushy-tailed woodrat (*Neotoma cinerea*), long-tailed vole (*Microtus longicaudus*) and montane vole (*Microtus montanus*) each accounted for less than 1% of the total small mammal relative abundance during September 1976 (Table 2.3-2).

The golden-mantled ground squirrel was captured at three sampling sites but was most abundant at the pinyon-juniper/south slope site.

The thirteen-lined ground squirrel was captured only at the flat sagebrush sampling site on 84 Mesa (3.03 individuals per 100 trap nights).

The long-tailed vole and the montane vole were both captured most frequently at the bottomland meadow sampling site while the sagebrush vole was most abundant at the upland meadow sampling site.

The bushy-tailed woodrat was captured only at north and south slope pinyon-juniper sites during September 1976.

Adult weights were averaged for small mammal species captured on each grid. Only the initial capture weights were used in average weight determinations.

Shannon-Weiner species diversity indices are presented for each grid in Table 2.3-3. Although some of the results are not directly comparable due to differential trapping efforts allocated to the various grids, both north and south slope pinyon-juniper grids showed high species diversity. Diversity was also high on Douglas-fir, aspen, bottomland meadow, and pinyon-juniper/sagebrush grids.

Pitfall trapping - Pitfall trapping was conducted during live trapping operations in September 1976. One masked shrew (*Sorex cinereus*) and one long-tailed vole were captured at the rabbitbrush sampling site. One masked shrew was also taken in a pitfall trap at the aspen sampling site.

Stomach analysis and reproductive effort - Deer mice were reproductively active at all sample locations during July 1976. Least chipmunks were active at the pinyon-juniper/south slope and mixed brush sample sites. The average litter size, calculated from placental

Table 2.3-3. Shannon-Weiner diversity indices (H'), unbiased estimates of H' (E(H')), variance of H' (var (H')), maximum expected value of H' (H'(max)), and equitability (J) for all small mammal grids during sample period 9, September 1976, for RBOSP

Grid Designation	Vegetation Type	H'	E(H')	var(H')	H'(max)	J
1	Bottomland meadow	1.114	1.056	0.015	1.386	0.804
2	Sagebrush	0.986	0.960	0.004	1.099	0.897
3	Rabbitbrush	0.692	0.683	0.000	0.693	0.998
4	Pinyon-juniper/mixed brush	0.871	0.848	0.009	1.099	0.793
5	Mixed brush	0.469	0.448	0.013	1.099	0.427
6	Pinyon-juniper/sagebrush	1.143	1.108	0.008	1.609	0.710
7	Upland meadow	0.826	0.782	0.012	1.099	0.752
A	Greasewood-sagebrush	0.923	0.912	0.003	1.609	0.573
B	Pinyon-juniper (south slope)	1.376	1.359	0.004	1.792	0.768
C	Pinyon-juniper (north slope)	1.288	1.274	0.002	1.609	0.800
D	Sagebrush	0.825	0.814	0.003	1.386	0.595
E	Mixed brush	0.751	0.738	0.002	1.099	0.683
F	Douglas fir	1.352	1.316	0.002	1.386	0.976
G	Aspen	1.256	1.213	0.009	1.609	0.781

scars, was 6.3 for the deer mouse and 6.5 for the least chipmunk. Long-tailed voles collected at the aspen sample site were the only small mammals examined in July 1976 that had embryos. Litter size, calculated from embryos, was 4.0 for the long-tailed vole.

Stomach contents of deer mice collected during July 1976 contained primarily seed parts and succulent vegetation. Seeds comprised the highest percentage of deer mouse stomach contents at both pinyon-juniper sites and at mixed brush and sagebrush sampling sites. Invertebrate and vertebrate material occurred less often in deer mouse stomachs. The highest percentage of invertebrate material was from deer mouse samples collected in north-facing pinyon-juniper while deer mice collected from pinyon-juniper/south slope sites showed the highest percentage of vertebrate material in their stomach contents. Invertebrate and vertebrate material occurred more often in deer mice stomachs than in least chipmunk stomachs. Deer mice collected from greasewood-sagebrush had empty stomachs. Stomach contents of the least chipmunks collected during July 1976 contained primarily seeds. Succulent parts occurred most frequently in chipmunk stomachs collected in greasewood-sagebrush and sagebrush. Long-tailed voles collected at the aspen sampling site during July 1976 contained only vegetal material (40% seed; 60% succulent) in their stomachs.

Night spotlight census - Night spotlight censuses for medium-sized mammals, particularly lagomorphs, were conducted on the nights of October 26 and 27, 1976. Road and weather conditions were favorable and the entire 30-mile census route was sampled on both nights.

Population densities have been calculated for lagomorph species, cottontail and white-tailed jackrabbit, only. Mule deer, elk, and a coyote were also observed during these spotlight censuses and this information will be included on distribution maps presented in the final report.

Estimated population densities for the cottontail and white-tailed jackrabbit of 0.09 and 0.17 animals per hectare respectively are relatively high as compared with previous data from this survey. Many white-tailed jackrabbits were noted in the sparse sage and open grassy areas on Cathedral Bluffs and along the gas line right-of-way.

2.3.4 Large Mammals

Pellet Group Counts - Mule deer pellet group counts for summer 1976 accumulations were conducted September 12-16, 1976. No pellet groups were found on the transects located on Tract C-a (1,5,6, and 7) or on transect 13 south of the tract. The transect with the highest pellet group index over summer 1976 (Transect 12), was located in mixed brush vegetation at higher elevations southwest of Tract C-a. Transects west and north of Tract C-a exhibited pellet group indices that were half or less than that found on transect 12. Transects northwest of Tract C-a generally had lower pellet group indices than those transects located west or southwest of the tract.

2.3.9 Terrestrial Invertebrates

Greasewood sagebrush-

Samples taken during July and September 1976 were identified and enumerated during the period September through October 31, 1976.

The estimated density of ground-dwelling invertebrates captured in pitfalls from the greasewood-sagebrush vegetation type in July 1976 was 49.6 invertebrates per m^2. Mites (Acari) was the most abundant order and had the highest density at 34.97 per m^2. Ants (Hymenoptera) and springtails (Collembola) were the second and third most abundant orders captured, accounting for 35.41% of the total invertebrates captured and a combined density of 8.78 invertebrates per m^2. Saprovores and predators were the dominant feeding types contributing 36.8% and 35.8% of the total captures respectively. Nearly all of the saprovores were springtails and orbatid mites, and all of the predators were spiders (Araneida) and prostigmatid mites.

The densities of invertebrate groups captured in pitfalls at the greasewood-sagebrush vegetation type in September 1976 totaled 25.28 invertebrates per m^2. Mites accounted for 62.6% of the total invertebrate captures and contributed 11.88 invertebrates per m^2. Most of the mites captured were in the suborder Prostigmata which accounts for 54.2 percent of the total invertebrate captures in the predator feeding type. The second largest feeding category, saprovores (33.3% of the pitfall captures), consisted of a variety of invertebrate orders including mites, springtails, bristletails (Thysanura), booklice, (Psocoptera), and harvestmen (Phalangida).

Litter samples from the greasewood-sagebrush vegetation type in July 1976 yielded invertebrate densities varying from 47.4 to 1371.6 invertebrates per kilogram of litter. These densities produced an average of 515.9 invertebrates per kilogram litter and a standard error of 231.5. Mites contributed 65% of the total captures with 290 individuals, and booklice and thrips (Thysanoptera) each contributed 11% of the captures. Sixty-one percent of all captures were saprovores, including most of the mites and all of the booklice.

Invertebrate captures from the litter at the greasewood-sagebrush vegetation type in September 1976 averaged 1361.2 invertebrates per kilogram of litter with a standard error of 409.8. The average is based on data from five samples which varied from 260.4 to 2432.9 invertebrates per kilogram litter. The most numerous invertebrate groups taken in September 1976 litter samples were mites with 607 individuals and booklice with 467 individuals. All of the booklice and most of the mites were saprovores, giving this feeding type 65.9% of the total litter captures in September 1976. Predators, the remaining abundant feeding type with 27.1% of total captures, were mainly prostigmatid mites.

Herbaceous sweeping of the ground layer vegetation of the greasewood-sagebrush vegetation type in July 1976 yielded 786 invertebrates in 100 sweeps. Forty percent of the total captures were thrips (314 individuals) and an additional 29% was relatively evenly divided among leafhoppers (Cicadellidae), delphacid planthoppers (Delphacidae), eulophid wasps (Eulophidae), and trixoscelidid flies (Trixoscelididae). Three of the abundant groups (thrips, leafhoppers, and delphacid planthoppers) were the dominant contributors to the herbivore feeding type which accounted for 65.5% of the total invertebrate captures.

The greasewood-sagebrush vegetation type herbaceous vegetation sweeps contained 347 invertebrates in September 1976. Globular springtails accounted for 38% of the total captures (133 individuals). The second and third most abundant invertebrate groups were mites and ants with 12% and 10% of the captures, respectively. The abundance of globular springtails in the September herbaceous sweep captures is partially responsible for the large percentage (64.3%) of invertebrate captures which were herbivores.

Five Trap D-Vac samples were taken from rabbitbrush each sampling period at the greasewood-sagebrush site. One hundred-ninety four invertebrates were taken in July 1976, giving density estimates ranging from 484.9 to 2970.9 invertebrates per cubic meter of vegetation. These densities produced a calculated average of 1551.0 invertebrates per cubic meter of rabbitbrush with a standard error of 479.9. The most abundant groups captured were mites (43 individuals), leafhoppers (33 individuals), and thrips (31 individuals). Herbivores were the most numerous invertebrates found on rabbitbrush and contributed 59.8% of the total captures. Leafhoppers and thrips were the most abundant plant feeders in addition to a variety of families in the orders Hemiptera, Homoptera, and Coleoptera.

Five hundred-eighty nine invertebrates were captured in September 1976 by vacuuming rabbitbrush in the greasewood-sagebrush vegetation type. The resultant density estimates ranged from 1353.9 to 5134.2 invertebrates per cubic meter of rabbitbrush for an average of 3055.8 and a standard error of 657.9. Thrips made up 46% of the total invertebrates captured, and an additional 26% of the total invertebrates captured was evenly divided among weevils (Curculionidae) and ants. The combined capture totals of thrips and weevils plus those for aphids (aphidadae) and leafhoppers accounted for nearly all of the captures in the herbivore feeding type. Beating samples taken from tall sagebrush plants in the greasewood-sagebrush habitat in July 1976 contained 581 invertebrates. Sixty-seven percent of the total captures were contributed by two species groups of thrips. The large number of thrips was the primary reason that 92.5% of the captures were herbivores although 10 other plant feeding insect groups were captured. By September 1976 the large numbers of thrips were gone from sagebrush beating samples at the greasewood-sagebrush site, resulting in only 113 invertebrate captures. Forty-eight percent of this total consisted of platygasterid wasps (Platygasteridae), which explains the large percentage (49.6%) of the beating captures in the flower feeding category.

Aerial sweeps taken from sagebrush foliage in the greasewood-sagebrush vegetation type contained 232 invertebrates in July 1976. Six species groups of invertebrates contributed greater than 5% of the total captures including thrips (17%), leafhoppers (16%), jumping spiders (Salticidae - 11%), plant bugs (Miridae - 9%), mites (9%), and eulophid wasps (5%). The variety of abundant invertebrate groups was also reflected in the breakdown of total captures by feeding type. The three most abundant feeding types (herbivores, flower feeders, and predators) each contained at least one of the abundant invertebrate groups.

September 1976 aerial sweep captures from sagebrush at the greasewood-sagebrush site contained 69 invertebrates nearly half of which were platygasterid wasps. As in September 1976 beating samples from sagebrush, the presence of large numbers of platygasterid wasps accounts for the high percentage of the total captures in the flower feeder category.

Results of 10 days of trapping invertebrates with a Malaise trap at the greasewood-sagebrush site in July 1976 yielded an estimated 3872 invertebrates. Numerically dominant groups included gall midges (Cecidomyiidae - 15%), winged reproductive ants (10%), tachinid flies (Tachinidae - 9%), adult moths (Lepidoptera - 8%), anthomyiid flies (Anthomyiidae - 7%), bee flies (Bombyllidae - 7%) and leafhoppers (5%). Gall midges, tachinid flies, and anthomyiid flies were described as unknown in feeding type which accounts for most of the 32.6% of the total captures assigned to the feeding type. The most abundant feeding type, flower feeders, was made up of a variety of fly and wasp families in addition to the abundant groups of bee flies and adult moths.

Malaise trap captures from the greasewood-sagebrush vegetation type in September 1976 totaled 406 individuals. There were a variety of families with greater than 5% of the captures (20 individuals), including anthomyiid flies and leafhoppers which were the most abundant groups taken. The large number of anthomyiid flies (96 individuals) accounts for most of the 39.4% of the total captures in the unknown feeding type.

Pinyon-juniper/South Slope-

Pitfall samples from the pinyon-juniper/south slope vegetation type yielded a density of 11.86 invertebrates per m^2 in July 1976 due mainly to the large numbers of mites captured. Ants and springtails were the only other groups with greater than 10% of the total captures. Predators dominated the July 1976 captures because nearly all of the mites were in the suborder Prostigmata. By September 1976, pitfall captures were reduced to 245 invertebrates yielding a density estimate of 2.8 invertebrates per m^2.

The low density estimate is a result of daily capture total fluctuations for almost one-half of the invertebrate groups captured. The numerically dominant groups in the September 1976 pitfall samples were mites, ants, and springtails. Predators were again the most abundant feeding type (42% of the captures) and consisted primarily of prostigmatid mites and spiders. The remaining captures were divided among the herbivore, saprovore, omnivore, and unknown feeding categories.

Captures from the litter at the pinyon-juniper/south slope site in July 1976 exhibited densities ranging from 41.6 to 306.7 invertebrates per kilogram of litter for an average of 127.5 and a standard error of 47.4. The majority of the captures were orbatid mites (65%), elongate-bodied springtails (Entomobryidae - 8%), and ants (7%). The large number of orbatid mites and elongate-bodied springtails accounts for nearly all of the saprovores. Saprovores contributed 75.1% of the July 1976 litter captures.

An average of 534.9 invertebrates per kilogram of litter was taken from five litter samples at the pinyon-juniper/south slope site in September 1976. The average is based on a range of densities from 11.0 to 2467.2 invertebrates per kilogram of litter. Elongate-bodied springtails (Isotomidae) accounted for 75% of the 1372 captures. The springtails were primarily responsible for the large percentage (90.6%) of saprovores in the samples.

Herbaceous sweep samples from the pinyon-juniper/south slope vegetation contained 51 invertebrates, nearly one-third of which were leafhoppers. All other invertebrate groups captured contributed less than 8 individuals. Herbivores were the most abundant group captures (72.5% of the total). Nine herbivorous insect species were taken in low numbers in addition to the abundant leafhoppers. Forty-five percent of the 40 invertebrates captured by herbaceous sweeps from the pinyon-juniper/south slope site in September 1976 were evenly divided among three insect families; leafhoppers, leaf beetles (Chrysomelidae), and weevils. All three of the abundant families plus a variety of non-abundant invertebrate groups contributed to the 67.5% of the total herbaceous sweep captures in the herbivore-feeding category.

Trap D-Vac samples taken from shadscale in the pinyon-juniper/south slope vegetation type in July 1976 yielded an average of 1794.2 invertebrates per cubic meter vegetation and a standard error of 612.4. Variation in the number of invertebrates per cubic meter ranged from 348.1 to 3544.7. Leafhoppers, globular springtails, and mites contributed 35%, 11%, and 11%, respectively, of the 87 invertebrates captured. The dominant feeding types were herbivore (66.7% of the Trap D-Vac captures) and predator (21.8%). Leafhoppers and globular springtails made up the majority of herbivores, and the predator feeding category consisted of mesostigmatid mites and a variety of spider families.

Forty-two invertebrates were captured from shadscale in the pinyon-juniper/south slope habitat in September 1976. The number of invertebrates per cubic meter vegetation ranged from 0 to 2864.8 for an average of 1077.2 and a standard error of 529.6. Abundant groups captured included leafhoppers (24% of the Trap D-Vac captures), immature ensign scales (Coccoidea - 23%), and dictynid spiders (Dictynidae - 14%).

Beating of pinyon pine foliage from the pinyon-juniper/south slope vegetation type produced 85 invertebrates in July 1976. Globular springtails contributed 33% and plant bugs contributed 18% of the captures. These two families account for nearly all of the herbivores captured. Globular springtails again accounted for the largest portion of beating captures from pinyon pine at the pinyon-juniper/south slope site in September 1976. Other abundant groups included mites, scales, and eulophid wasps. Feeding habits were dominated numerically by herbivores which accounted for 53.8% of the September 1976 beating captures. Springtails, scales, and a variety of other insect groups present in small numbers contributed to the herbivore total.

One hundred-seventy five invertebrates were obtained by beating the foliage of juniper in the pinyon-juniper/south slope habitat during July 1976. Weevils contributed 30% of the captures, globular springtails - 25%, and plant bugs - 17%. The three families accounted for most of the 78.9% of the beating captures in the herbivore feeding type. In September 1976 only 2 weevils were found among the 66 invertebrates captured by beating juniper foliage in the pinyon-juniper/south slope habitat. The bulk of the captures (70%) were globular springtails. Springtails also accounted for the majority of the herbivores, the most numerous feeding type captured in September 1976 beating samples from juniper.

Aerial sweep samples from the foliage of pinyon pine at the pinyon-juniper/south slope site contained 68 invertebrates in July 1976. Three insect families contained greater than 15% of the captures including checkered beetles (Cleridae - 12 individuals), pteromalid wasps (Pteromalidae - 13 individuals), and eulophid wasps (18 individuals). Checkered beetles and pteromalid wasps contributed most of the 42.6% of the captures in the predator feeding type. Aerial sweep samples from pinyon pine at the pinyon-juniper/south slope site in September 1976 contained only 6 invertebrates in 6 species groups.

Aerial sweeping of juniper foliage at the pinyon-juniper/south slope site in July 1976 produced 27 invertebrates, 10 of which were weevils. No other invertebrate family contributed more than 2 individuals. The herbivore feeding type contained 51.9% of the total captures due primarily to the large number of weevils. By

September 1976, the capture total from beating juniper foliage at the pinyon-juniper/south slope habitat was down to 11 individuals. The most abundant family taken was that of the pteromalid wasps. This family and 2 spider families contributed all of the predators, the most abundant feeding type.

The Malaise trap in the pinyon-juniper/south slope vegetation type contained an estimated 2432 invertebrates in July 1976. Adult moths and gall midges contributed 43% of the captures. Flower feeders dominated the Malaise trap captures in July 1976. Adult moths and a variety of wasps, bees, and flies contributed to the total. Malaise trap captures dropped from the July 1976 total to 726 invertebrates in September 1976 at the pinyon-juniper/south slope site. Anthomyiid flies contributed 30% of the total followed by braconid wasps and adult moths each with 10% of the total captures. The anthomyiid flies accounted for a large part of the unknown feeding type which was the most abundant feeding type in September 1976.

Pinyon-juniper/North Slope-

Results for the pinyon-juniper/north slope group dwelling invertebrates sampled by pitfalls in July 1976 showed 739 individuals captured. The calculated invertebrate density was 218.15 invertebrates per m^2 of which mites accounted for 212.08 of this total. All of the mites captured were in the suborder Prostigmata, explaining the large percentage of pitfall captures (75.4) in the predator feeding type. Four hundred-eleven invertebrates were captured in pitfalls at the pinyon-juniper/north slope habitat in September 1976. However, because mites, the numerically dominant group, did not meet the assumptions for density estimate methods, the calculated density was only 2.76 invertebrates per m^2. Most of the mites were in the suborder Prostigmata which made predators the most abundant invertebrate group collected.

Samples from the litter at the pinyon-juniper/north slope site in July 1976 contained invertebrates at densities ranging from 6.9 to 1187.7 invertebrates per kilogram litter. The average number of invertebrates per kilogram litter was 321.6 with a standard error of 222.7. Ninety-one percent of the captures were in three invertebrate groups, isotomid springtails (57%), mites (24%), and entomobryid springtails (10%). All three groups are detritus feeders explaining why nearly all captures were in the saprovore feeding type. By September 1976, the average density of invertebrates per kilogram litter at the pinyon-juniper/north slope site had declined to 54.5 with a standard error of 14.9. The average was based on a density range of 6.9 to 1187.7 invertebrates per kilogram litter. Numerically dominant groups included ants (29% of litter captures), mites (26%), and springtails and booklice, each with 13% of the litter captures. The omnivore feeding category, which made up 29.4% of the litter captures, consisted entirely of ants. The remaining abundant invertebrate groups accounted for all of the 45.2% of the litter captures in the saprovore feeding type.

A total of 102 invertebrates were captured in herbaceous sweeps from the pinyon-juniper/north slope vegetation type in July 1976. Psyllids (Psyllidae) contributed 80 individuals, and accounted for much of the numerical dominance of the herbivore feeding type. Only 14 invertebrates were captured from the herbaceous vegetation at the pinyon-juniper/north slope site in September 1976. Leafhoppers and globular springtails accounted for 43% and 36% of the total, respectively.

Trap D-Vac samples taken from sagebrush at the pinyon-juniper/north slope site contained invertebrates at densities ranging from 435.0 to 27728.3 invertebrates per cubic meter vegetation in July 1976. The densities give an average of 11,171.9 invertebrates per cubic meter vegetation and a standard error of 4946.5. Eighty-four percent of the captures were contributed by springtails (62%) and mites (22%), the majority of which were saprovores. Trap D-Vac captures from sagebrush at the pinyon-juniper/north slope site declined to an average of 3004.7 invertebrates per cubic meter vegetation in September 1976. The average is based on a range of densities from 1046.9 to 6549.6 invertebrates per cubic meter vegetation. Numerically dominant invertebrate groups included leafhoppers (36% of the captures), thrips (17%), dictynid spiders (13%), and scales (11%). The abundant groups were the major contributors to the 74.6% of the total captures in the herbivore feeding type and 23.7% in the predator feeding type.

Beating samples from pinyon pine at the pinyon-juniper/north slope site in July 1976 yielded 152 invertebrates. Seventy-eight percent of the captures were contributed by 4 insect families, globular springtails, leafhoppers, plant hoppers, and aphids. All are herbivores, which explains the large percentage of beating captures in that feeding type. Of the abundant insect families in July 1976, only aphids were common in the beating samples from pinyon pine at the pinyon-juniper/north slope site in September 1976. Mites in the suborder Orbatei accounted for over one-half of the beating captures and all of the saprovores, the dominant feeding type represented.

Beating samples from pinyon in the pinyon-juniper/north slope vegetation type in July 1976 contained 28 invertebrates. The most numerous family was that of plant bugs which contributed 5 individuals. Most of the invertebrates captured were included in one of three feeding types, flower feeders (32.1% of the captures), predators (28.6%), and herbivores (17.9%). Juniper beating samples taken in September 1976 from the pinyon-juniper/north slope vegetation type contained 13 invertebrates. Mites were the numerically dominant group with six individuals.

Aerial sweep samples from pinyon pine foliage at the pinyon-juniper/north slope site in July 1976 contained 59 invertebrates. Plant bugs were the only group to contribute more than 10% of the captures. Herbivores were the numerically dominant group, contributing 45.8% of the captures. By September 1976, the aerial sweep captures from pinyon pine at the pinyon-juniper/north slope site declined to 8 individuals. Five of the captures were spiders which accounts for the high percentage of captures in the predator feeding type.

Sweeping of the foliage of juniper at the pinyon-juniper/north slope site yielded 29 invertebrates in July 1976. Numerically dominant groups included aphids with five individuals and gall midges with four individuals. Five feeding types contained at least two of the 29 captures led by the herbivore feeding type with 12 individuals. Twenty-three invertebrates were captured from juniper foliage by sweeping in September 1976 at the pinyon-juniper/north slope site. No family contributed more than 4 individuals, but the order Araneida was represented by 8 individuals in four families. The large number of spiders is partly responsible for the high percentage (56.5%) of all captures in the predator feeding type.

Malaise trap captures for the July 1976 sampling period at the pinyon-juniper/north slope habitat contained an estimated 4496 invertebrates. Fifty-nine percent of this total was contributed by gall midges (30%) and chironomids (Chironomidae - 29%). The dominant feeding type was flower feeders with 53.4% of the captures. Contributors to the flower feeding level included chironomids, adult moths, and a variety of bees, wasps, and flies. By September 1976, the estimated Malaise trap captures from the pinyon-juniper/north slope habitat declined to 583. Numerically dominant groups also changed from those in July to Anthomyiidae (30% of the captures) and adult moths (70% of the captures) in September.

Sagebrush-

Pitfall captures from the upland sagebrush vegetation type contained 804 invertebrates in July 1976. Less than 24% of the captures met the assumptions needed for density estimates resulting in a calculated density of 4.66 invertebrates per m^2. Ants were the numerically dominant group with 58.1% of the captures. Ants were also the only omnivores, the predominant feeding type taken in July 1976 pitfall samples. By September 1976, the pitfall captures from the upland sagebrush habitat had declined to 300 invertebrates, but the density estimate increased to 16.92 invertebrates per m^2. Three invertebrate groups, flies, ants, and mites, each contributed between 22% and 23% of the total captures. The variety and relatively even distribution of captures among different insect groups accounted for the distribution of captures in different feeding types. Four feeding types contained greater than 20% of the captures led by predators with 27.3% of the captures.

Samples from sagebrush litter at the upland sagebrush site contained 498 invertebrates in July 1976. Calculated densities ranged from 191.7 to 2398.5 invertebrates per kilogram litter for an average of 770.8 and a standard error of 412.7. Seventy-eight percent of the captures were contributed by two invertebrate groups, springtails (40%) and mites (38%). The large number of springtails and mites also accounts for the saprovore feeding type containing 67.7% of all captures. Litter samples taken from the upland sagebrush habitat in September 1976 reached densities ranging from 100.0 to 1759.6 invertebrates per kilogram litter for an average of 826.9 and a standard error of 292.2. Mites accounted for 66% of the captures and also contributed most of the saprovores, the largest feeding type.

Herbaceous sweep samples from the upland sagebrush vegetation type contained 40 invertebrates in July 1976. Leafhoppers and ants contributed the majority of the captures although more than one species group was taken in each family. The numerically dominant feeding types, herbivore and omnivore, reflect the distribution of captures in the abundant families. By September 1976, the herbaceous sweep captures from the upland sagebrush habitat declined to 21 individuals. Leafhoppers were the only group to contribute more than 3 individuals, accounting for 29% of the captures. Leafhoppers were also the major contributors to the numerically dominant herbivore feeding type.

Two hundred forty-five invertebrates were captured by Trap D-Vac sampling of sagebrush from the upland sagebrush vegetation type in July 1976. Calculated numbers of invertebrates per cubic meter of vegetation ranged from 260.8 to 5362.5 for an average of 1985.3 and a standard error of 973.2. Sixty percent of the captures were mites. Trap D-Vac samples from the upland sagebrush site in September 1976 contained 89 invertebrates. Calculated invertebrate densities ranged from 1044 to 4058.5 invertebrates per cubic meter of sagebrush for an average of 2836.8 and a standard error of 631.3. Numerically dominant groups were leafhoppers with 32 individuals and platygasterid wasps with 14 individuals. The two abundant families were also the major contributors to the 47.2% of the captures in the herbivore feeding type and 22.5% in the flower feeding type, respectively.

Malaise trap samples taken in the upland sagebrush habitat contained an estimated 882 invertebrates in July 1976. Forty percent of the captures were adult moths. No other invertebrate group contributed over 10% of the total Malaise captures. A variety of wasps, bees, and flies, as well as the abundant moths, contributed to the flower feeding type which contained 55.3% of the captures. Malaise trap captures from the upland sagebrush habitat declined in September 1976 to 193 individuals from a reported 882 individuals in July, 1976. Over one-half of the captures were contributed by three species of anthomyiid flies. The anthomyiid flies also accounted for most of the unknown feeding type which made up 61.7% of the captures.

Mixed brush-

Pitfall results for July 1976 at the mixed brush site revealed a total of 729 invertebrate captures. Nearly all of the captures met the assumptions of the density estimate method, resulting in a calculated density of 40.13 invertebrates per m^2. Four groups contained greater than 10% of the captures including ants (31.82%), bristletails (18.11%), mites (15.36%), and beetles (Coleoptera - 12.89%). The combined capture totals of bristletails and mites account for nearly all of the saprovores in the feeding type classification. Omnivores, the numerically dominant feeding type, were made up exclusively of ants.

A total of 360 invertebrates was captured in mixed brush habitat pitfalls in September 1976. The two numerically dominant groups, mites and springtails, were not included in the density estimate, resulting in a low estimate of 2.46 invertebrates per m^2. The majority of the mites captured were in the suborder Orbatei, and combined with springtails, accounted for nearly all of the 43% of the total captures in the saprovore feeding type.

Results from litter samples taken in the mixed brush vegetation type in July 1976 yielded a range of 203.8 to 527.1 invertebrates per kilogram of litter for an average of 328.5 and a standard error of 61.9. Eighty-one percent of the captures were contributed by three invertebrate groups including mites (42%), ants (20%), and springtails (19%). The numerical dominance of captures in the saprovore feeding type (55.7% of the captures) was also accounted for by the abundance of mites and springtails. Captures from litter samples at the mixed brush site increased to 456 invertebrates in September 1976. Calculated densities ranged from 183.2 to 500.0 invertebrates per kilogram litter, giving an average of 372.7 and a standard error of 55.6. Springtails contributed 62% of the captures and nearly all of the members of the numerically dominant saprovore feeding type.

Herbaceous sweep samples from the mixed brush vegetation type contained 269 invertebrates in July 1976. Only globular springtails and leafhoppers contained greater than 10% of the captures. Seventy percent of the captures were herbivores, most of which were springtails, leafhoppers, plant bugs, and psyllids. Samples from the herbaceous vegetation of the mixed brush habitat yielded 238 invertebrates in September 1976. Major contributors to the total were ants, weevils, jumping spiders (Salticidae), globular springtails, and leafhoppers. The combined totals of weevils, springtails, and leafhoppers accounted for most of the 32.8% of the total captures in the herbivore feeding type.

Serviceberry and snowberry were sampled by Trap D-Vac at the mixed brush site. Results of sampling serviceberry in July 1976 yielded density estimates ranging from 313.3 to 5989.3 invertebrates per cubic meter of vegetation. These estimates gave an average of

2823.7 invertebrates per cubic meter of vegetation and a standard error of 1188.8. Seventy-two percent of the captures were contributed by five invertebrate groups including mites (39%), springtails (16%), leafhoppers (7%), scales (5%), and ants (5%). Saprovores were the largest feeding type with 44.3% of the captures. By September 1976, invertebrate samples from serviceberry at the mixed brush site declined to 16 individuals. Density estimates ranged from 33.7 to 611.2 invertebrates per cubic meter of vegetation for an average of 176.4 and a standard error of 109.4. Psyllids and leafhoppers were the most frequently captured insect groups, accounting for most of the 62.5% of the captures in the herbivore feeding type.

Trap D-Vac samples from snowberry in the mixed brush vegetation type yielded an average density of 914.8 invertebrates per cubic meter of vegetation and a standard error of 431.0. The average is based on a range of densities from 249.4 to 2566.9 invertebrates per cubic meter vegetation. One-half of the captures were contributed by moth immatures, halictid bees (Halictidae), and mites. Five feeding types each contained greater than 10% of the captures including predators (25%), herbivores (25%), flower feeders (20%), omnivores (15%), and unknowns (12.5%).

September Trap D-Vac samples from snowberry at the mixed brush site contained 23 invertebrates and averaged 451.5 invertebrates per cubic meter of vegetation. The average is based on a range of calculated densities from 0 to 848.8 invertebrates per cubic meter vegetation. Platygasterid wasps and leafhoppers were the only insect groups contributing more than 3 individuals. Herbivores and predators each contributed 34.8% of the Trap D-Vac captures for September.

Malaise trap samples from the mixed brush vegetation type yielded 2768 invertebrates in July 1976. Chironomid, gall midge, and adult moth captures accounted for 52% of the total invertebrates taken. A variety of wasps, bees, flies, and adult moths accounted for the high percentage (59%) of captures in the flower feeding type. By September 1976 Malaise trap captures from the mixed brush habitat declined to 396 invertebrates. Forty-one percent of the captures were dark-winged fungus gnats (Sciaridae). Flower feeding insects, including the dark-winged fungus gnats, accounted for 81.8% of the captures.

2.4 Aquatic Studies

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development.

In order to fulfill these objectives, 35 sampling stations were selected to represent the aquatic habitats present. Emphasis was placed on Yellow Creek and the White River which are permanently flowing streams. Sampling periods discussed herein include July - August 1976 and August - September 1976, The condition (dry or flowing) of each station during this period and dates on which aquatic samples were taken during the July - August 1976 and August - September 1976 are shown in Table 2.4-1. Physical, chemical and biological measurements are taken concurrently at each sampling site.

2.4.1 Physical Measurements and Water Chemistry

During the August - September 1976 sampling period, Stations 6, 10 - 12, and 15 - 19 were dry.

A summary of selected parameters for the Yellow Creek and White River stations is presented below.

AUGUST - SEPTEMBER 1976

Parameter	Yellow Creek	White River
Specific conductance (μmhos)	4000	900 - 3200
pH	8.5 - 8.7	8.4 - 8.5
Alkalinity, Total ($CaCO_3$mg/l)	1456 - 1694	217 - 240
Chloride (mg/l)	149 - 162	39 - 45
Sulfate (mg/l)	469 - 519	59 - 65
Dissolved solids (mg/l)	2459 - 2562	550 - 617
Turbidity	58 - 303	4 - 21
Dissolved oxygen (mg/l)	5.7 - 7.6	9.1 - 9.9
Temperature (^{0}C)	10 - 11	16 - 21

Comparison of the physical and chemical data for the August - September 1976 sampling period with that of August - September 1975 indicates that water temperatures were generally higher in Yellow Creek in August - September 1976 than in 1975 (when the range was 6 - 14^{0}C) while the temperatures in the White River were more variable in August - September 1976 than in the same period of 1975 (when range was 15 - 18^{0}C). Turbidity was higher in Yellow Creek during the August - September 1976 sampling than during the comparable period in 1975 (18 - 26 JTU), probably due to the increased disturbance by cattle. Turbidity was lower in the White River in August - September 1976 than in 1975 (6 - 14 JTU). The ranges of concentration of dissolved solids were much narrower in August - September 1976 than during the same period

Table 2.4-1. Dates Sampling for RBOSP Aquatic Baseline Studies, July - August 1976 and August - September 1976

	July - August 1976		August - September 1976	
Station	Date Sampled	Flow Condition	Date Sampled	Flow Condition
1	7-15-76	Flowing	9-16-76	Flowing
2	7-15-76	Flowing	9-16-76	Flowing
3	7-20-76	Flowing	9-15-76	Flowing
4	7-19-76	Flowing	9-15-76	Flowing
5	7-27-76	Flowing	9-16-76	Flowing
6	7-14-76	Dry	9-14-76	Dry
7	7-19-76	Flowing	9-15-76	Flowing
8	7-14-76	Flowing	9-14-76	Flowing
9	7-19-76	Flowing	9-17-76	Flowing
10	7-20-76	Dry	9-15-76	Dry
11	7-20-76	Dry	9-15-76	Dry
12	7-20-76	Dry	9-17-76	Dry
13	7-22-76	Flowing	8-26-76	Flowing
14	7-22-76	Flowing	8-26-76	Flowing
15	7-14-76	Dry	9-14-76	Dry
16	7-15-76	Dry	9-16-76	Dry
17	7-14-76	Dry	9-14-76	Dry
18	7-14-76	Dry	9-14-76	Dry
19	7-27-76	Flowing	9-15-76	Dry
20	7-23-76	Flowing	9-14-76	Flowing
21	7-23-76	Flowing	9-14-76	Flowing
22	7-23-76	Flowing	9-14-76	Flowing
23	8-04-76	Flowing	9-03-76	Flowing
24	8-07-76	Flowing	9-02-76	Flowing
25	8-07-76	Flowing	9-02-76	Flowing
26	8-07-76	Flowing	9-02-76	Flowing
27	8-02-76	Flowing	8-31-76	Flowing
28	8-02-76	Flowing	8-31-76	Flowing
29	8-02-76	Flowing	8-31-76	Flowing
30	8-06-76	Flowing	9-01-76	Flowing
31	8-06-76	Flowing	9-01-76	Flowing
32	8-06-76	Flowing	9-01-76	Flowing
33	8-03-76	Flowing	8-30-76	Flowing
34	8-03-76	Flowing	8-30-76	Flowing
35	8-03-76	Flowing	8-30-76	Flowing

in 1975 in both Yellow Creek (1,900 - 3,500 mg/l in 1975) and the White River (485 - 822 mg/l in 1975). Specific conductance varied less in Yellow Creek in 1975 (2,800 - 4,100 μmhos in 1975), whereas, the range of specific conductance observed in the White River in August - September 1976 was greater than that observed in August - September 1975 (775 - 2,500 μmhos).

2.4.2 Phytoplankton

A total of 112 taxa was observed in the July - August phytoplankton collection.

During the July - August 1976 period, the most abundant phytoplankton taxa at the headwater stations were the diatoms *Achnanthes minutissima*, *Navicula cryptocephala*, *Nitzschia frustulum*, and unidentified flagellates. At the tract stations, the most abundant taxa included *Achnanthes minutissima*, *Navicula cryptocephala*, *Nitzschia latens*, *Nitzschia capitellata*, and unidentified flagellates. In Yellow Creek, the most abundant taxa were the diatoms *Cyclotella meneghiniana*, *Nitzschia latens*, *Nitzschia microcephala*,and unidentified flagellates. In the White River, the most abundant taxa were the diatoms *Gomphonema olivaceum*, and *Cocconeis pediculus*, unidentified flagellates, and the euglenophytes *Euglena* spp.

A total of 95 taxa was observed in the August - September 1976 collections phytoplankton collection.

During the August - September period, the most abundant phytoplankton taxa at the headwater stations were the diatoms *Achinanthes minutissima*, *Navicula crytocephala*, *Nitzschia denticula*, and unidentified flagellates. At the tract stations, the most abundant taxa were the diatoms *Achnanthes minutissima*, *Navicula*, *cryptocephala*, *Nitzschia denticula*, and unidentified flagellates. In Yellow Creek, the most abundant taxa were the diatoms *Cyclotella meneghiniana* and *Nitzschia holsatica*, and identified flagellates, whereas in the White River, the most abundant taxa were *Cocconeis pediculus*, *Navicula salinarum* var. intermedia, Nitzschia holsatica, and unidentified flagellates.

Comparison of phytoplankton data from the two sampling periods with data collected during similar periods in 1975 indicates that diatoms were generally the most abundant algae taxa in the phytoplankton of the study area during both years. Phytoplankton abundance was generally low throughout the study area and phytoplankton constitutes a secondary source of primary production (periphytic algae is the primary source) in waters of the study area.

2.4.3 Zooplankton

A total of 66 zooplankton taxa was observed in the July - August 1976 collections.

The July - August 1976 Zooplankton densities varied considerably among the habitats, ranging from over 70,000 org/m^3 in the White River. The high densities at the pond stations on tract were a direct result of the abundance of ostracods at Stations 14. A high diversity of litteral rotifers occurred at all the stations other than the those at the headwaters. Centropyxis spp. were the dominant protozoan forms at all habitats. Cladocera dominated the Crustacea of the Yellow Creek stations, but *Bryocamptus hiemalis*, a copepod, was often the only Crustacean at the headwaters.

In the August - September 1976 collections, a total of 60 zooplankton taxa was observed.

Zooplankton densities were generally lower in August - September 1976 than in previous months. Densities ranged from approximately 4,000 org/m^3 in the White River to over 12,000 org/m^3 at the pond stations on tract. As in previous months, *Centropyxis* spp. dominated the protozoan fauna at all habitats. In addition, peritrich ciliates were often abundant at Yellow Creek and White River stations. The rotifer fauna of the headwater stations, was composed predominately of unidentified monogonont rotifers. A more diverse fauna including *Lepadella*, *Lecane*, and *Euchlanis* occurred at the other habitats. The dominant Crustacea at the headwater stations included *Bryocamptus hiemalis*, *Paracyclops fimbriatus poppei* and Ostracods, whereas *Alona circumfinbriata*, *Pleuroxus aduncus*, and nauplii were the more abundant forms at Yellow Creek. Few Crustacea occurred in the August - September White River samples.

2.4.4 Periphyton

A total of 77 algae taxa was observed in the periphyton during the July - August 1976 period.

During the July - August period, the most abundant algae taxa in the periphyton of the headwater stations were the diatoms *Achnanthes minutissima*, *Gomphonema intricatum*, *Navicula cryptocephala*, and the chrysophyte *Bicoeca lacustris*. At the tract stations, the most abundant taxa included the diatoms *Achnanthes minutissima*, *Navicula crytocephala*, *Cymbella affinia* and the chrysophyte *Bicoeca lacustris*. In Yellow Creek, the dominant taxa were the diatoms *Navicula crytocephala*, *Nitzschia frustulum*, *Cyclotella meneghiniana*, and the blue-green algae Calothrix spp., whereas in the White River, the dominant taxa included the diatoms *Epithemia sorex* and *Amphora ovalis* var. *pediculus*, and the blue-green algae *Calothrix* spp.

The most abundant algae taxa collected from artificial substrates in Yellow Creek were *Cyclotella meneghiniana*, *Mastoglota elliptica*, and *Nitzschia frustulum*. In the White River, *Epithemia sorex* and *Cocconeis placentula* were most abundant.

A total of 104 taxa was observed in the August - September 1976 period.

During the August - Se½tember period, the most abundant taxa in the periphyton of the headwater stations were the blue-green algae *Calothrix* spp., the chrysophyte *Bicoeca lacustris*, and the diatoms *Achnanthes minutissima*, *Achnanthes lanceolata*, and Navicula *crytocephala*. In Yellow Creek, the dominant taxa were *Navicula cryptocephala*, *Nitzschia frustulum*, *Nitzschia holsatica*, and *Nitzschia latens*, whereas in the White River, the dominant taxa included the blue-green algae *Calothrix* spp., and the diatoms *Amphora ovalis* var. *pediculus*, *Epithemia* sorec, and *Cocconeis pediculus*.

The most abundant algae taxa collected from artificial substrates in in the White River were the blue-green algae *Calothrix* spp., and the diatoms *Cocconeis placentula*, *Gomphonema intricatum*, and *Epithemia sorex*.

Comparison of periphyton data from the two sampling periods with data collected during similar periods in 1975 indicates that there were some differences in species composittion between the two years.

2.4.5 Benthos

Benthos taxa observed during the July - August 1976 sampling are listed in Table 2.4-2.

During the July - August sampling, the most abundant taxa at the headwater stations were Chironomidae, Oligochaeta, *Hyallela azteca*, and Tricladida. At the tract stations, the most abundant taxa were Chironomidae, Simuliidae, and Oligochaeta. The most abundant taxa at the Yellow Creek habitat included Chironomidae, Oligochaeta, Simuliidae, and Ceratopogonidae. At the White River stations, the most abundant taxa included *Tricorythodes*, *Rhithrogena*, Chironomidae, and Oligochaeta.

Benthos taxa observed during the August - September 1976 sampling period are listed in Table 2.4-3

During the August - September sampling period, the most abundant taxa at the headwater stations were Chironomidae, Simuliidae, Ceratogonidae, Hyallela axteca, and Oligochaeta. The most abundant taxa at the tract stations were the Nematoda, Chironomidae, Simuliidae, Oligochaeta. At the Yellow Creek habitat, Oligochaeta, Simuliidae, Chironomidae, and Ceratopogonidae were the most abundant; and the most abundant taxa at the White River stations were the Oligochaeta, *Tricorythodes*, Chironomidae, and *Rhithrogena*.

Table 2.4-2 Macroinvertebrate Taxa observed during RBOSP Aquatic Baseline Studies, July - August 1976

- Platyhelminthes
  - Turbellaria
    - Tricladida

- Nematuda

- Mollusca
  - Gastropoda
    - Basommatophora
      - Lymnaeidae
        - *Lymnaea* sp.
      - Physidae
        - *Physa* sp.

- Annelida
  - Hirudinea
    - Rhynchobdellida
      - Glossiphonidae
        - *Helobdella Stagnalis*
  - Oligochaeta
    - Haplotaxida
      - Haplotaxidae
        - *Haplotaxis* sp.
      - Enchytraeidae
      - Tubificidae
        - *Ilydrilus templetoni*
        - *Limnodrilus claparedeianus*
        - *Limnodrilus hoffmeisteri*
        - *Limnodrilus profundicula*
        - *Limnudrilus udekemianus*
        - *Rhyacodrilinae* sp.
        - *Rhyacodrilinae Sodalis*
        - *Tubifex tubifex*

      - Naididae
        - *Chaetogaster diastrophus*
        - *Nais* sp.
        - *Nais Behningi*
        - *Pristina* sp.

- Arthropoda
  - Arachnoidea
    - Acari

Table 2.4-2 (Continued)

- Crustacea
  - Amphipoda
    - Talitridal
      - *Hyalella azteca*
- Insecta
  - Collembola
  - Ephemeruptera
    - Baetidae
      - *Baetis* sp.
      - *Callibaetis* sp.
      - *Dactylobaetis* sp.
    - Heptageniidae
      - *Epeorus longimanis*
      - *Heptagenia* sp.
      - *Rhithrogena* sp.
    - Leptophlebiidae
      - *Traverella albertana*
    - Leptophlebiidae
      - *Choroterpes* sp.
    - Ephemerellidae
      - *Ephemerella* sp.
    - Tricorythidae
      - *Tricorythodes* sp.
    - Caenidae
      - *Caenis* sp.
    - Polymitarcidae
      - *Ephoron* sp.
  - Odonata
    - Zygoptera
      - Coenagrionidae
    - Zyguptera
      - Coenagrionidae
        - *Argia* sp.
    - Anisoptera
      - Gomphidae
  - Plecoptera
    - Euholognatha
      - Capniidae
    - Systellognatha
      - Nemouridae
        - *Nemoura* sp.
      - Perlodidae
        - *Isoperla* sp.
      - Perlodidae
        - *Isogenus* sp.
      - Chloroperlidae
      - Perlidae

Table 2.4-2 (Continued

- *Claassenia sabulosa*
- Hemiptera
  - Veliidae
    - *Rhagovelia* sp.
  - Corixidae
- Coleoptera
  - Hydraenidae
    - *Ochthebius* sp.
  - Haliplidae
    - *Haliplus* sp.
    - *Peltodytes* sp.
  - Dytiscidae
    - *Deronectes* sp.
  - Hydrophilidae
    - *Berosus* sp
  - Dryopidae
    - *Helichus* sp.
  - Elmidae
    - *Microcylloepus* sp.
    - *Zaitzevia* sp.
- Trichoptera
  - Glossosomatidae
  - Hydropsychidae
    - Hydropsyche sp.
    - *Cheumatopsyche* sp.
  - Hydroptilidae
    - *Agraylea* sp.
    - *Mayatrichia* sp.
  - Limnephilidae
  - Leptuceridae
    - *Decetis* sp.
  - Brachycentridae
    - *Brachycentrus* sp.
- Lepidoptera
  - Pyralidae
- Diptera
  - Tipulidae
    - *Ormosia* sp.
    - *Dicranota* sp.
    - *Pedicia* sp.
    - *Limnophila* sp.
    - *Holorusia* sp.
  - Ceratopogonidae
  - Chironomidae
    - Tanypodinae
      - Macropelopia

Table 2.4-2 (Continued)

  - *Psectrotanypus* (*Apsectrotanypus*) larvae
  - *Thienemannimyia* group
- Diamesinae
  - *Monodiamesa*
  - *Odontomesa*
  - *Pseudodiamesa pertinax*
- Orthocladiinae
- Orthocladiinae
  - *Acricotopus*
  - Cardiocladius
  - *Corynoneura*
  - *Cricotopus*
  - *Cricotopus* (*Cricotopus*)
  - *Cricotopus* (*Cricotopus*) *bicinctus*
  - *Cricotopus* (*Cricotopus*) *trifascia*
  - *Cricotopus* (*Isocladius sylvestris* grp.)
  - *Diplocladius*
  - *Eukiefferiella*
  - *Krenosmittia*
  - *Limnophyes*
  - *Mesosmittia*
  - *Nanocladius*
  - *Orthocladius*
  - *Orthocladius* (*Euorthocladius*)
  - *Paracladius*
  - *Parakiefferiella*
  - *Paraphaenocladius*
  - *Parametriocnemus*
  - *Parorthocladius*
  - *Pseudosmittia*
  - *Thienemanniella*
- Chironominae
- Chironomini
  - *Chironomus*
  - *Cryptochironomus*
  - *Harnischia*
  - *Lauterburniella*
  - *Microtendipes*
  - *Paracladopelma*
  - *Paratendipes*
  - *Phaenopsectra*
  - *Polypedilum* (*Polypedilum* sp.)
  - *Polypedilum* (*Polypedilum*) *fallax* group
  - *Polypedilum* (*Polypedilum*) *tripodura* group
  - *Pseudochironomus*

Table 2.4-2 (Continued)

Stictochironomus sp.
Tanytarsini
Tanytarsus sp.
Cladotanytarsus sp.
Micropsectra sp.
Paratanytarsus
Rheotanytarsus
Simuliidae
Simulium sp.
Stratiomyidae
Euparyphus sp.
Tabanidae
Chrysops sp.
Rhagionidae
Atherix variegata
Empididae
Anthomyiidae
Limnophora aequifrons
Limnophora discreta

Table 2.4-3 Macroinvertebrate taxa observed during RBOSP aquatic baseline studies, August - September 1976

- Platyhelminthes
  - Turbellaria
    - Tricladida

- Naematoda

- Mollusca
  - Gastropoda
    - Basommatophora
      - Lymnaeidae
        - *Lymnaea* sp.

- Annelida
  - Hirudinea
    - Rhynchobdellida
      - Glossiphoniidae
        - *Helobdella stagnalis*
  - Oligochaeta
    - Haplotaxida
        - *Haplotaxis* sp.
      - Enchytraeidae
      - Tubificidae
        - *Limnodrilus Hoffmeisteri*

        - *Limnodrilus udekemianus*
        - *Rhyacodrilinae* sp.
        - *Tubifex tubifex*
      - Naididae
        - *Chaetogaster diastrophus*
        - *Nais* sp.
        - *Nais behningi*
        - *Pristina* sp.

- Arthropoda
  - Arachnoidea
    - Acari
  - Crustacea
    - Amphipoda
      - Talitridae
        - *Hyalella azteca*
  - Insecta
    - Collembola
    - Ephemeroptera
      - Baetidae

Table 2.4-3 (Continued)

- - - *Baetis* sp.
    - *Callibaetis* sp.
    - *Dactylobaetis* sp.
  - Heptageniidae
    - *Heptagenia* sp.
    - *Rhithrogena* sp.
  - Leptophlebiidae
    - *Traverella albertana*
    - *Choroterpes* sp.
  - Ephemerellidae
    - *Ephemerella* sp.
  - Tricurythidae
    - *Tricorythodes* sp.
  - Caenidae
    - *Caenis* sp.
- Odonata
  - Zygoptera
    - Ccenagrionidae
  - Anisoptera
    - Gomphidae
- Plecoptera
  - Euholognatha
    - Capniidae
  - Systellognatha
    - Perlodidae
      - *Isogenus* sp.
    - Perlidae
      - *Claassenia sabulosa*
- Hemiptera
  - Corixidae
- Coleoptera
  - Dytiscidae
    - *Deronectes* sp.
  - Hydrophilidae
  - Elmidae
  - Elmidae
    - *Zaitzevia* sp.
- Trichoptera
  - Glossosomatidae
  - Hydropsychidae
    - *Hydropsyche* sp.
  - Hydroptilidae
  - Limnephilidae
  - Leptoceridae
  - Leptoceridae
    - *Oecetis* sp.
  - Brachycentridae
    - *Brachycentrus* sp.
- Lepidoptera

TABLE 2.4-3 (Continued)

- Pyralidae
- Diptera
  - Tipulidae
    - *Ormosia* sp
    - *Pedicia* sp
    - *Limnophila* sp
    - *Holorusia* sp
  - Psychodidae
    - *Pericoma* sp
  - Dixidae
    - *Dixa* sp
  - Ceratopogonidae
  - Ceratopogonidae
  - Chironomidae
    - Tanypodinae
      - *Nilotanypus* sp
      - *Psectrotanypus* (*Apsectrotanypus*)
      - *Thienemannimyia*
    - Diamesinae
      - *Diamesinae*
      - *Diamesa*
      - *Monodiamesa*
      - *Odontomesa*
      - *Prodiamesa*
      - *Pseudodiamesa* *pertinax*
    - Orthocladiinae
      - *Corynoneura*
      - *Cricotopus* (*Cricotopus*)
      - *Cricotopus* (*Cricotopus*) *bicinctus*
      - *Cricotopus*(*Isocladius*)
      - *Cricotopus* (*Isocladius*) *sylvestris* group
      - *Diplocladius*
      - *Eukiefferiella*
      - *Nanocladius*
      - *Orthocladius*
      - *Orthocladius* (*Euorthocladius*)
      - *Paracladius*
      - *Parakiefferiella*
      - *Paraphaenocladius*
      - *Parametriocnemus*
      - *Parorthocladius*
      - *Pseudosmittia*
      - *Thienemanniella*
    - Chironominae
    - Chironomini
      - *Chironumus*
      - *Crytochironomus*

TABLE 2.4-3 (Continued)

- *Paracladopelma*
- *Paratendipes*
- *Phaenopsectra*
- *Polypedilum*
- *Polypedilum* (*fallax* group)
- *Polypedilum* (*tripodura* group)
- *Pseudochironomus*
- Tanytarsini
  - *Tanytarsus*
  - *Cladotanytarsus*
  - *Micropsectra*
  - *Paratanytarsus*
  - *Rheotanytarsus*
- Simuliidae
  - *Simulium* sp.
- Stratiomyidae
  - *Euparyphus* sp.
- Tabanidae
  - *Tabanus* sp.
- Rhagionidae
  - *Atherix variegata*
- Empididae
- Syrphidae
- Anthomyiidae
  - *Limnophora aequifrons*
  - *Limnophora discreta*
- Muscidae

2.4.6 Sediment Chemistry

A summary of the results for the August - September 1976 period is presented below. Concentrations of the parameters correspond closely to those observed during the same 1975 sampling period with the exception of aluminum which was found in lower concentrations in Yellow Creek in 1976 than in 1975 (7,200 - 15,000 μg/g).

August - September 1976

Parameter (μg/g)	White River	Yellow Creek
Aluminum	3,300 - 11,000	4,600 - 13,500
Arsenic	3.1 - 6.4	3.4 - 7.7
Lead	5.4 - 18.0	6.8 - 13.0
Zinc	30 - 61	30 - 60

2.4.7 Macrophytes

During the August - September 1976 sampling period, aquatic macrophytes were observed at Stations 2, 4, 5, 7, 8, 14, and 19. At Stations 2, 4, and 7, Ranunculus cymbolaria was observed in low abundance. At Stations 5, Chara kierneri and Marsh Marigold, were present in moderate abundance. At Stations 8, the abundance of watercress Rorippa nasturtium aquaticum was low. At Station 14, Zannichellia palustris was abundant, whereas, sedges were observed in low abundance. At Station 19, Ranunculus cymbolaria was observed in very low abundance and rushes were present in rank abundance.

2.4.8 Fish

Fish data from the July - August 1976 sampling are presented in Table 2.4-4. A total of 465 fish, representing seven species, was captured in the White River. No fish were captured in Yellow Creek. The most abundant species were flannelmouth sucker and speckled dace. No game fish were observed. In July - August 1975, 201 fish representing 10 species were captured in the White River and no fish were captured in Yellow Creek. Flannelmouth suckers and speckled dace were also the dominant species in July - August 1975.

Fish data from the August - September 1976 sampling period are presented in Table 2.4-5. A total of 867 fish, representing eight species, was captured in the White River. No fish were captured in Yellow Creek. The most abundant species were speckled dace and mottled sculpin. During August - September 1975, 941 fish were captured in the White River and eight were captured in Yellow Creek. The most abundant fish captured at that time were speckled dace and flannelmouth sucker.

Table 2.4-4 List of fish species and numbers captured, White River and Lower Yellow Creek. RBOSP Aquatic Baseline Studies, July - August 1976.

Common Name	Scientific Name	Number Captured
Flannelmouth sucker	*Catostomus latipinnis*	180
Bluehead sucker	*Catostomus discobolus*	39
Roundtail chub	*Gila robusta*	1
Speckled dace	*Rhinichthys osculus*	163
Fathead minnow	*Pimephales promelas*	5
Mottled sculpin	*Cottus bairdi*	75
Carp	*Cyprinus carpio*	2

Table 2.4-5. List of fish species and numbers captured, White River and Lower Yellow Creek. RBOSP Aquatic Baseline Studies August - September 1976

Common Name	Scientific Name	Number Captured
Roundtail chub	*Gila robusta*	27
Flannelmouth sucker	*Catostomus latipinnis*	90
Bluehead sucker	*Catostomus discobolus*	54
Mottled sculpin	*Cottus bairdi*	211
Speckled dace	*Rhinichthys osculus*	384
Fathead minnow	*Pimephales promelas*	48
Red Shiner	*Notropis lutrensis*	4
Carp	*Cyprinus carpio*	49

2.4.9 Springs and Seepages

Approximate locations of springs and seepages on or near Tract C-a are shown on Figure 2.4-1. No additional springs or seepages have been observed since Progress Report 7.

2.4.10 Hydrology

The approximate stream velocities observed during August - September 1976 are presented in Table 2.4-6

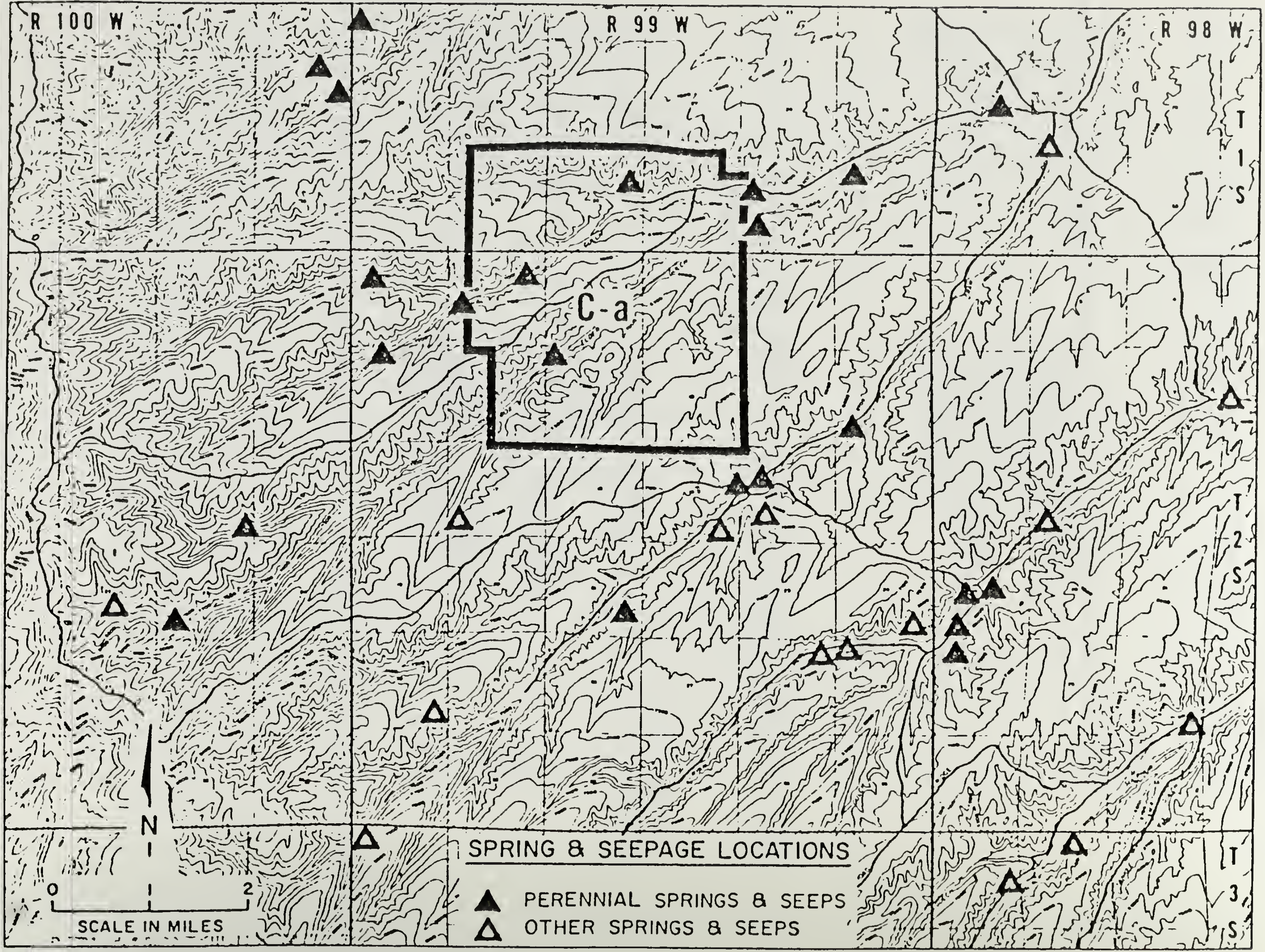

Figure 2.4-1. Spring and Seepage Locations

Table 2.4-6 Stream velocity during RBOSP Aquatic Baseline Studies, August - September 1976. (Results are expressed in feet per second and, where appropriate, are given for bank side (s) and point of maximum flow (m).)

Station	Velocity (ft/sec)		
	s	m	s
1		1.7	
2		1.0	
3		1.0	
4		2.0	
5		1.3	
7		1.7	
8		1.1	
9		2.0	
13		1.4	
14		1.5	
19		1.2	
20		1.2	
21		0.7	
22		1.5	
23		2.0	
24		1.1	
25		3.1	
26		2.1	
27		0.9	
28		0.8	
29		3.3	
30		3.3	
31		3.3	
32		2.5	
33	1.6;	2.0;	0.7
34	2.1;	2.8;	0.8
35	1.6;	3.3;	4.0

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[1] Stations 6, 10-12, and 15-18 were dry at the time of sampling

2.5 Other Environmental Programs

2.5.1 Soil Survey and Productivity Assessment Studies

2.5.1.1 Objectives (See Progress Report 7)

2.5.1.2 Methods (See Progress Report 7)

2.5.1.3 Results and Discussion

All field work for the soils program has been completed. A draft report is currently being reviewed and comments incorporated for the final soils report. Current plans envision completion of the final report by mid-January 1977. Some of the initial findings and conclusions include the following.

The chemical and physical properties of the soils of Tract C-a and of adjacent areas are typical of semi-arid regions in the western United States. Saline and sodic materials are found in the study area, but these traits appear to affect plant growth only when they are of relatively high magnitude and when they occur within the first 50 cm of soil. The concentration of macro- and micronutrients are generally within the ranges expected, however, some sampling sites had unusally high concentrations of nitrate or molybdenum. Trace element concentrations are within the ranges considered normal for surface soils and are nontoxic to plants and animals. Selenium was the only exception, and three sampling sites contained more plant-available selenium than is normally found in soils of semi-arid regions. The levels of background radioactivity are low and within the range considered nonsignificant to living organisms. Physical analyses pointed out that most of the soils of the study area are of coarse to medium texture and have the potential to retain sufficient water and nutrients for normal plant growth.

Many soil traits displayed an increase in concentration as depth increased. Salinity, pH, exchangeable sodium percentage and many plant nutrients increased significantly in concentration with increasing depth. Trace elements and physical properties were generally constant as depth increased.

In general, vegetation did not appear to significantly affect soil traits. However, greasewood was found to occur on saline, sodic and strongly alkaline soils. Nitrate, sulfate and selenium were also unusually high where greasewood dominated. A limited investigation of soils under individual pinyon pine trees and in open areas suggested that pinyon pine significantly influences many soil traits.

Soil traits of Tract C-a alone and of 84 Mesa alone are very similar to those of the entire study area. However, soils found on 84 Mesa are higher in electrical conductivity and contain higher concentrations of most water-soluble macronutrients than other soils of the study area.

Nine soil series are found in the study area. These series were mapped and an individual profile within each series was described. A comparison of the chemical and physical properties demonstrated that these soil series had very similar characteristics with the exception of the Torriorthent series. Soils of this series are saline, high in water-soluble macronutrients and generally high in the concentration of trace elements.

The depth and location of topsoil suitable for use in reclamation was determined. Topsoil depth ranged from 0 to 150 cm. Rock was the most common limiting factor to topsoil depth. In some areas, the presence of sodic or saline material limited the depth of topsoil.

Processed oil shale was analyzed and evaluated for use as a subsurface medium for plant growth. This shale was found to be highly saline, sodic and high in plant-available molybdenum.

2.5.2 Archaeological Survey

The final report, which was released in May 1976, is still under review by state and federal agencies. Comments are bring incorporated following a disussion with the reviewer. The cultural resource document included archaeological, historical and paleontological sections.

2.5.3 Revegetation Studies

2.5.3.1 1975 Revegetation Studies

Objectives and methods of the 1975 revegetation studies have been reported in previous progress reports. Field studies to estimate seedling emergence, survival, and percent cover have now been completed. Soil moisture samples from the 1975 revegetation plots (R_1 and R_2) have been collected and analyzed. The results of these experiements are currently being interpreted and will be included as a part of the RBOSP Revegetation Annual Report.

2.5.3.2 1976 Revegetation Studies

The objectives and methods of the 1976 revegetation studies were reported in Progress Report 8. The 1976 revegetation plot (R_3) was prepared and seeded during the quarter. A chacterization o f the native vegetation on the plot was completed in September prior to disturbance and soil sampled for determining soil chemistry and soil moisture were collected. Seedbed preparation was initiated in late September and completed in early November. Seedbed preparation consisted of the following steps:

- Removal and stockpiling of topsoil, subsoil, and fractured rock material from the plot

- Laying of plastic film over the entire cleared and leveled plot surface
- Placement and compaction of Tosco II processed shale over one-half of the plot of a compacted depth of approximately 20 inches
- Placement of "dummy shale" over the other half of the plot to a depth of 20 inches
- Placement of an artifical three-foot soil profile over the entire plot, using stockpiled soils materials
- Mulching

Planting was completed in November. Photographic records were made for each step of the plot preparation process. Measurements of processed shale density are shown in Table 2.5.3-1 and ocular estimates of the percentage of fines in the three-foot rock profile appear in Table 2.5.3-2.

Following completion of planting on R_3 the plot was fenced.

2.5.5 Trace Metals

Trace metals analysis is included in the soil survey and productivity assessment program (Section 2.5.12.)

2.5.12 Threatened and Endangered Species

Sandhill Crane Studies - The greater sandhill crane (*Grus canadensis tabia* is considered by the Colorado State Wildlife Commission (1973) to be an endangered species if found nesting within the state. This status applies only to the Colorado nesting population and does not apply to birds found feeding within the state or birds found migrating through the state.

Observations of sandhill cranes in the vicinity of Calamity Ridge and Little Duck Creek (17 April 1975), and 84 Mesa (25-30 April 1975) led to the initiation of special sandhill crane studies in the spring of 1975. These studies were continued during the fall of 1975 and spring of 1976, and were resumed during this reporting quarter.

The fall 1976 sandhill crane studies were initiated on 20 September 1976 and completed on 3 November 1976. The purpose of these surveys was to determine whether the birds returned to 84 Mesa or adjacent areas during the fall migration. The fall studies involved vehicle and foot surveys of 84 Mesa, Tract C-a, Stake Springs Draw, Corral Gulch, Yellow Creek and Duck Creek.

No sandhill cranes were observed in the vicinity of Tract C-a or 84 Mesa during the fall 1976 surveys. It appears, therefore,

Table 2.5.3-1. Processed shale density and depth measurements at three locations on the 1976 revegetation plot.[1]

Location	Total Depth (inches)	Sample Depth Where Collected	Density (lb/ft^3)	Average
1	21.5	8 1/2	109	
		13	100	
		18	113	107
2	22.5	7 1/4	97	
		14 1/4	101	
		19	113	104
3	22.5	7 3/4	81	
		13	116	
		19 1/2	102	100

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[1] Conducted by K. R. Server (RBOSP) and C. V. Braun (NUS)

Table 2.5.3-2. Ocular estimation of the percent fines present in the "Artificial Soil Profile" of the 1976 revegetation plot.[2]

Estimate 1	50%
2	45%
3	40%
Average	45%

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[1] Conducted by K. R. Server (RBOSP), J. C. Carter (CDM/Limnetics), and C. V. Braun (NUS)

that 84 Mesa is not an important migratory stopover for sandhill cranes.

Form 1279–3
(June 1984)

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TN 859 .C64 R565 no.

Rio Blanco Oil Shale
Project.
Progress report sum
Tract C-a oil shal

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